Chapter 8
Water Quality

8.0 Summary Comparison of Alternatives

A summary comparison of important water quality impacts is provided in Figures 8-0a and 8-0b. These figures provides information on the magnitude of the most pertinent water quality-related impacts, both adverse and beneficial, that are expected to result from implementation of the alternatives. Important impacts to consider include the potential for increased electrical conductivity, increased mercury levels in fish, and increased production of *Microcystis* in the Delta.

As depicted in Figure 8-0a, the modeling shows that all action alternatives would exceed the water quality objective for electrical conductivity (EC) in the Sacramento River at Emmaton. Alternatives 1A and 6A would exceed the objective more than the other alternatives would. The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions and 14% under the No Action Alternative late long-term (LLT) to 31% under Alternative 1A and 32% under Alternative 6A. Alternatives 4A, 2D, and 5A would result in the least exceedances of the threshold of 16%, 7%, and 10%, respectively. However, in reality, staff from DWR and Reclamation constantly monitor Delta water quality objectives. Their water system operational decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. It is likely that some of the objective exceedences simulated in the modeling would be avoided under the real-time monitoring and operational paradigm that would be in place to help prevent such exceedences.

Modeling results show that most of the action alternatives, as well as the No Action Alternative, would result in increased mercury levels in fish tissue concentrations at Delta locations. Alternatives 6A and 9 would result in the highest increases in mercury levels in fish tissue, increasing by up to 64% to 66% compared with Existing Conditions at certain Delta locations, and by up to 58% to 59%, compared to the No Action Alternative LLT. Alternative 4A would increase mercury levels in fish tissue by 8% or less compared with Existing Conditions and No Action Alternative early long-term (ELT), Alternative 2D would result in a 10% or less increase compared with Existing Conditions and No Action Alternative (ELT), and Alternative 5A would result in a 5% or less increase compared with Existing Conditions and No Action Alternative (ELT).

Modeling results show that the action alternatives would result in increased production of *Microcystis* in the Delta when compared with the No Action Alternative as a result of a number of factors. Blooms of *Microcystis* require high levels of nutrients and low turbidity, as well as high water temperature and, because the species is fairly slow growing, long residence time (Lehman et al. 2008; Lehman et al. 2013). In addition, low vertical mixing (due to low water flow) associated with high residence time allows *Microcystis* colonies to float to the surface of the water column, where they outcompete other species for light. Increases in ambient air temperature due to climate change relative to Existing Conditions are expected under all action alternatives. Increases in ambient air temperatures are expected to result in warmer ambient water temperatures, and thus conditions more suitable to *Microcystis* growth, in the water bodies of the State Water Project/Central Valley Project Export Service Areas. The incremental increase in long-term average air temperatures would be less at the ELT (2.0°F) than at the LLT (4.0°F). For Figure 8-0b, *Microcystis* predictions were ranked qualitatively, based on a combination of these factors. Lower numbers (e.g., 1 or 2) signify less suitable conditions for *Microcystis* blooms than higher numbers indicate (e.g., 4 or 5). The non-HCP alternatives (Alternatives 4A, 2D, and 5A), when compared to the No Action Alternative (ELT), would have a ranking of 2 because operations and the ELT timeframe under those alternatives would lead to less suitable conditions for *Microcystis* to bloom. The BDCP alternatives would have a ranking of 4, with the exception of Alternative 5, which would result in a ranking factor of 3; these alternatives would provide more suitable conditions for *Microcystis* to bloom.

Additional impacts discussed in the summary table include bromide concentrations, chloride levels, and increases in organic carbon and selenium. Executive Summary Table ES-8 provides a summary of all impacts disclosed in this chapter.

8.0.1 Readers Guide

Chapter 8, *Water Quality,* describes the environmental setting and potential impacts of the project alternatives on water quality in and upstream of the Sacramento-San Joaquin Delta. The chapter provides the results of the evaluation of the effects of implementing the project on water quality constituents under No Action Alternative conditions and 18 action alternatives. This guide is intended to help the reader understand the organization of the chapter and the impact analysis of the constituents of interest.

8.0.2 Overview

Chapter 8 is organized much like the other chapters in this document, but because of the chapter's greater scope, this guide is provided to help the reader navigate through the various components of the chapter.

The chapter is divided into three main sections.

- 8.1 *Environmental Setting/Affected Environment*
- 8.2 *Regulatory Setting*
- 8.3 *Environmental Consequences*

These sections parallel the same sections in other resource chapters.

8.0.3 Environmental Setting/Affected Environment

The first part of the chapter is the Environmental Setting and Affected Environment section. This section provides a general description of the existing environment, including the following:

- Overview of the Sacramento and San Joaquin River Watersheds
- Water Management and the State Water Project and Central Valley Project Systems
- Primary Factors Affecting Water Quality
- Beneficial Uses
- Water Quality Objectives and Criteria
- Water Quality Impairments

Chapter 8 – Water Quality	Alternative																		
	Existing Condition	No Action	1A	1B	1C	2A	2B	2C	3	4	5	6A	6B	6C	7	8	9	4A	2D	5A
WQ-5: Bromide (CM1) - Percent increase in long-term average concentration at Barker Slough	-	-2%	38/43%	38/43%	38/43%	22/26%	22/ 26%	22/ 26%	34/38%	40/44%	23/27%	19/22%	19/22%	19/22%	-2/1%	4/8%	19/23%	-2/2%	-2/2%	-4/0%
		LTS	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A[a]	S/A[a]	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-7: Chloride - Percent of years when 150 mg/L water quality objective exceeded at CCPP#1[b]	7%	0	13%	13%	13%	13%	13%	13%	7%	7%	13%	13%	13%	13%	20%	13%	13%	0%	0%	0%
		S	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-11: EC- Percent of days Emmaton objective would be exceeded	6%	14	31%	31%	31%	26%	26%	26%	30%	27-29%[c]	25%	32%	32%	32%	19%	22%	18%	16%[c]	7%[c]	10%[c]
		S	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-13: Mercury (CM1) - Maximum percent increase in fish tissue concentrations at Delta locations	6%	6%	8/10%	8/10%	8/10%	13/11%	13/11%	13/11%	6/8%	15/12%	8/7%	64/58%	64/58%	64/58%	45/39%	46/41%	66/59%	8/7%	10/9%	5/3%
		LTS	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA

Notes

[a] While the long-term average increases in bromide would be low, the drought period increases would be 34% for Alternative 7 and 50% for Alternative 8, relative to Existing Conditions and the No Action Alternative. These increases in the drought period were considered significant/adverse.

[b] Water quality degradation as measured by use of available assimilative capacity also played a significant role in determining effects by alternative, and degradation varied by alternative.

[c] Alternative 4 does not include a change in compliance location from Emmaton to Threemile Slough, but the modeling used to evaluate the alternative did include the change. Thus, although the percent of days the Emmaton objective was exceeded is high, it is expected that under the alternative it would be similar to the No Action.

Key

Level of significance or effect **before** mitigation
(Quantity of impact: number of sites, structures, acres, etc. affected)

Increasing level of significance →

Bromide - Percent increase (%)	<0	1 - 20	21 - 40	>40
Chloride - % of years objective exceeded (%)	0	1-12	13-19	>20
EC - percent of days objective exceeded (%)	<10	11 - 20	20 - 30	>30
Mercury (CM1) - Percent increase (%)	<10	10 - 20	21 - 50	>50
Mercury (CM2-CM22) - restoration acres	0	1 - 100	25,000	65,000
Organic Carbon (CM1) - mg/L	<0.1	0.1 - 0.5	0.6 - 1.0	>1.0
Organic Carbon (CM2-CM21) - restoration acres	0	1 - 100	25,000	65,000
Selenium - Exceedance Quotient	0.87	0.88 - 0.93	0.94 - 0.99	>1.0
Microcystis - relative rank	1	2	3	4

Level of significance or effect **after** mitigation
(CEQA Finding / NEPA Finding)

CEQA Finding		NEPA Finding	
NI	No Impact	B	Beneficial
LTS	Less than significant	NE	No Effect
S	Significant	NA	Not Adverse
SU	Significant and unavoidable	A	Adverse

n/a not applicable
\> greater than
< less than
≈ about equal to

Continued on Figure 8-0b

Figure 8-0a
Comparison of Impacts on Water Quality

Chapter 8 – Water Quality (continued)	Existing Condition	No Action	Alternative 1A	1B	1C	2A	2B	2C	3	4	5	6A	6B	6C	7	8	9	4A	2D	5A
WQ-14: Mercury(CM2-CM21) - Amount (acres) of new tidal habitat restoration that could contribute additional methylmercury	0	0	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	25,000	65,000	65,000	65,000	65,000	65,000	65,000	59	65	55
		-- [d]	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A
WQ-17: Organic Carbon (CM1) - Maximum increase in long-term average DOC (mg/L) at interior Delta locations	--	<0.1	0.3	0.3	0.3	0.4	0.4	0.4	0.2	0.4	0.2	1.2	1.2	1.2	0.8	0.8	0.7	0.2	0.2	0.1
		LTS	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-18: Organic Carbon (CM2-CM21) - Amount (acres) of new tidal habitat restoration that could contribute additional DOC	0	0	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	25,000	65,000	65,000	65,000	65,000	65,000	65,000	59	65	55
		-- [d]	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-25: Selenium (CM1) - High threshold exceedance quotient for whole body sturgeon (concentration divided by threshold) during drought period	.87	0.87	0.89	0.89	0.89	0.92	0.92	0.92	0.89	0.93	0.89	1.1	1.1	1.1	1.1	1.1	1.2	0.91	0.89	0.90
		LTS	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	LTS/NA	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA
WQ-32 and 33: Microcystis (CM1-CM21) - potential for increased production in Delta [e]	--	2	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	2	2	2
		5	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	S/A	LTS/NA	LTS/NA	LTS/NA

Notes

[d] CM2-CM21 are not a component of Existing Conditions or the No Action Alternative, thus, no impact call was made for this effect in the EIR/EIS.

[e] The Microcystis was qualitative. Thus, the severity of the impact was established as a rank from 1 to 4, with the rankings based on the alternative-specific factors that would contribute to increased Microcystis production, including restoration area, diversions of Sacramento River water at the north intakes, and net Delta outflow.

Key

Level of significance or effect **before** mitigation
(Quantity of impact: number of sites, structures, acres, etc. affected)

Increasing level of significance →

Bromide - Percent increase (%)	<0	1 - 20	21 - 40	>40
Chloride - % of years objective exceeded (%)	0	1-12	13-19	>20
EC - percent of days objective exceeded (%)	<10	11 - 20	20 - 30	>30
Mercury (CM1) - Percent increase (%)	<10	10 - 20	21 - 50	>50
Mercury (CM2-CM22) - restoration acres	0	1 - 100	25,000	65,000
Organic Carbon (CM1) - mg/L	<0.1	0.1 - 0.5	0.6 - 1.0	>1.0
Organic Carbon (CM2-CM21) - restoration acres	0	1 - 100	25,000	65,000
Selenium - Exceedance Quotient	0.87	0.88 - 0.93	0.94 - 0.99	>1.0
Microcystis - relative rank	1	2	3	4

Level of significance or effect **after** mitigation
(CEQA Finding / NEPA Finding)

CEQA Finding		**NEPA Finding**	
NI	No Impact	B	Beneficial
LTS	Less than significant	NE	No Effect
S	Significant	NA	Not Adverse
SU	Significant and unavoidable	A	Adverse

n/a not applicable
> greater than
< less than
≈ about equal to

Figure 8-0b
Comparison of Impacts on Water Quality (continued)

- Water Quality Constituents of Concern
- Selection of Monitoring Stations for Characterization of Water Quality
- Existing Surface Water Quality—this characterization is meant to provide a general understanding of water quality conditions and historical monitoring data in the study area. The discussion is not meant to explicitly define the Existing Conditions for CEQA purposes. The CEQA baseline, *Existing Conditions*, is defined in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and for the purposes of quantitative water quality assessments (as described in Sections 8.3.3 and 8.3.4) is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented in this section.

8.0.4 Regulatory Setting

Numerous federal, state and local acts, rules, plans, policies, and programs define the framework for regulating water quality in California. The second part of the chapter, *Regulatory Setting*, describes water quality requirements that are applicable to the project alternatives.

8.0.5 Environmental Consequences

The third part of the chapter describes the anticipated environmental consequences of the no action alternatives and each of the 18 action alternatives. This part of the chapter is divided into four sections. The first two sections (Sections 8.3.1 and 8.3.2) provide an important foundation for the analysis of the environmental effects. The third section contains the analysis of each alternative's impacts as well as associated environmental commitments and mitigation measures that would be implemented to reduce those impacts. The final section discusses cumulative effects. The four sections are as follows:

- Methods of Analysis (Section 8.3.1), which presents information on models used and their linkages, methods specific to three different regions of the affected environment (Upstream of the Delta, Plan Area/Delta, and State Water Project (SWP)/Central Valley Project (CVP) Export Service Area), mercury and selenium bioaccumulation models, and constituent-specific considerations used in the assessment. The constituent-specific considerations used in the assessment section specifically identifies the water quality criteria/objectives used in the assessments and other methodological details specific to each constituent.
- Determination of Adverse Effects (Section 8.3.2), which describes results of the constituent screening analysis, a description of the comparisons made in the Effects and Mitigation Approaches section, and the criteria for determining if an impact is adverse and/or significant.
- Effects and Mitigation Approaches (Section 8.3.3), which provides a full discussion by alternative (No Action Alternative and 15 BDCP alternatives) of impacts and mitigation approaches of the BDCP conservation measures on water quality constituents. ***Important information about the organization of the Effects and Mitigation Approaches section is provided below***.
- Effects and Mitigation Approaches – Alternatives 4A, 2D, and 5A (Section 8.3.4), which provides a full discussion by alternative (No Action Alternative [ELT] and three non-HCP alternatives) of impacts and mitigation approaches of the non-HCP alternatives on water quality constituents.

***Important information about the organization of the Effects and Mitigation Approaches section is provided below*.**

- Cumulative Analysis (Section 8.3.5) addresses the potential for the project alternatives to act in combination with other past, present, and probable future projects or programs to create a cumulatively significant adverse impact.

8.0.6 Organization of the Effects and Mitigation Approaches Discussion (Sections 8.3.3 and 8.3.4)

The Effects and Mitigation Approaches sections (Sections 8.3.3 and 8.3.4) contains the analysis of the impacts and mitigation on water quality constituents for each alternative. The sections begin with an analysis of the No Action Alternative and is then followed by the action alternatives. A discussion of cumulative effects is included as a standalone section (Section 8.3.5).

Each alternative begins with a brief description of the alternative itself, including the capacity of the North Delta intake structures, the operational scenario, and any other major aspects of the alternative. Following this is the “Effects of the Alternative on Hydrodynamics” section, which includes a brief discussion of how water quality constituents would be expected to change in general due to changes in Delta hydrodynamics, the general changes in hydrodynamics due to the alternative, and the types of water quality changes seen in the alternative.

To the extent there are similarities between the No Action Alternative or Alternative 1A and the other alternatives, the subsequent alternative analyses refer back to either the No Action Alternative or the Alternative 1A analysis. This approach allows the analysis of Alternative 1A and the action alternatives to minimize redundancy and emphasize those aspects of the alternatives that are different from the No Action Alternative or Alternative 1A. Hence, readers wishing to gain a better understanding of the impacts and mitigation for Alternatives 1B–2C, 3, 4, 5, and 6A–9 should first become familiar with the presentation of impacts and mitigation for the No Action Alternative and Alternative 1A. Alternatives ending in “B” or “C” are different from the corresponding “A” variant of the alternatives. The difference is the physical type and/or location of water conveyance infrastructure. In all other respects, including water operations, the B and C variants are identical to the corresponding A variant. For example Alternative 1B is different from Alternative 1A in that Alternative 1A would convey water from the north Delta to the south Delta through pipelines/tunnels, while Alternative 1B would convey water through a surface canal. The effects on water quality do not differ otherwise, so the analysis of the B and C alternatives is condensed and refers the reader back to the corresponding A alternative for specific details.

Restoration and other conservation measures for the BDCP alternatives are the same among all but two of the BDCP alternatives. The exceptions are Alternatives 5 and 7. Under Alternative 5, 25,000 acres of tidal habitat would be restored, compared to 65,000 acres for Alternative 1A. Under Alternative 7, there would be 20,000 acres of seasonally inundated floodplain and 40 miles of channel enhancement, versus 10,000 acres of seasonally inundated floodplain and 20 miles of channel margin enhancement under Alternative 1A. However, these differences do not substantially affect water quality impact conclusions discussed in this chapter, and, thus, for Alternatives 1B through 2C, 3, 4, 5, and 6A through 9, the reader is referred back to Alternative 1A for details. To help guide the reader, bookmark their location in the chapter, and maintain consistency with Alternative 1A, the impact headers are retained in these other alternatives and followed by a general summary in some instances and cross reference to appropriate analysis located elsewhere in the chapter.

The conservation measures (see Table 3-3 in Chapter 3, *Description of Alternatives*) that are analyzed for each water quality constituent under each BDCP alternative are treated in two distinct categories for purposes of impact analysis. Those categories are as follows:

- Potential impacts resulting from water operations and maintenance of Conservation Measure (CM) 1. CM1 provide for the development and operation of a new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities). For the purposes of the assessment, the study area was divided into the three regions which are discussed separately for each constituent for CM1:
    - Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).
    - Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
    - SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta-Mendota Canal, and South Bay Aqueduct).
- Potential impacts resulting from other conservation measures, under the BDCP alternatives, these are CM2–CM21(these include habitat restoration measures that provide for the protection, enhancement and restoration of habitats and natural communities and measures to reduce the direct and indirect adverse effects of other stressors on covered species).

Operations-related water quality changes (i.e., CM1 under the BDCP alternatives) would be partly driven by geographic and hydrodynamic changes resulting from restoration actions (i.e., altered hydrodynamics attributable to new areas of tidal wetlands (CM4), for example). There is no way to disentangle the hydrodynamic effects of CM4 and other restoration measures from CM1, since the Delta as a whole is modeled with both CM1 and the other conservation measures implemented. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects were included in the modeling assessment of operations-related water quality changes (CM1 under the BDCP alternatives). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a water quality constituent to the Delta, are discussed within the impact heading for CM2–CM21.

After the discussion for each water quality constituent, construction-related water quality effects are discussed. As opposed to discussing construction-related water quality effects for each water quality constituent within the constituent-specific assessments described above, construction-related water quality effects on all constituents are discussed in a single section for all CM1–CM21. Following the discussion of construction-related water quality effects are impact discussions for *Microcystis* and San Francisco Bay. Within each BDCP alternative discussion section, the impacts of the conservation measures are analyzed in the following order:

- Ammonia
- Boron
- Bromide
- Chloride
- Dissolved Oxygen

- Electrical Conductivity
- Mercury
- Nitrate
- Organic Carbon
- Pathogens
- Pesticides and Herbicides
- Phosphorus
- Selenium
- Trace Metals
- TSS and Turbidity
- Construction-related Activities
- *Microcystis*
- San Francisco Bay

The presentation and organization of water quality impacts associated with Alternatives 4A, 2D, and 5A (the non-HCP alternatives) follows the same format described above. The primary difference is that impacts are described for "facilities operations and maintenance" without the label of "CM1," because the water conveyance facilities under non-HCP alternative are not proposed as a conservation measure, a term of art normally associated with Section 10 of the Endangered Species Act. Similarly, Environmental Commitments are proposed for Alternatives 4A, 2D, and 5A, rather than conservation measures; therefore, there are separate impact discussions for Environmental Commitments for each constituent, rather than an impact discussion for CM2–CM21.

It should be noted that because aquatic life beneficial uses are the only uses expected to be affected by temperature changes under the various alternatives, this chapter cross-references to Chapter 11, *Fish and Aquatic Resources*, for all impact assessments for temperature.

8.0.7 NEPA and CEQA Impact Conclusions

The analysis in Chapter 8 has been prepared in accordance with NEPA and CEQA. Each impact is presented as a NEPA analysis, using the appropriate terminology for presence or absence of adverse effects. This analysis is followed by a CEQA conclusion, which is identified as such. The CEQA conclusion uses the terminology appropriate to describing the presence or absence of significant impacts.

In some instances, the NEPA and CEQA discussions differ for a particular impact discussion because NEPA and CEQA have different points of comparison (or "baselines" in CEQA terms). The NEPA point of comparison for each alternative is based on the comparison of the action alternatives, Alternatives 1A–2C, 3, 4, 5, and 6A– 9, at 2060 and Alternatives 4A, 2D, and 5A at 2025, with the No Action Alternatives considered at 2060 (No Action Alternative [LLT]) and 2025 (No Action Alternative [ELT]) in the absence of the action alternatives. The CEQA baseline is based on the comparison of the action alternatives with existing conditions. Consistent with this, the NEPA point of comparison accounts for anticipated climate change conditions at 2060 and 2025, whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the action alternatives are due primarily to both the impacts of proposed alternative as well as future climate change conditions (sea level rise and altered precipitation patterns).

8.1 Environmental Setting/Affected Environment

This section defines the environmental setting/affected environment for surface water quality, reviews the environmental and regulatory setting with respect to water quality, and provides an assessment of existing water quality conditions in the study area (the area in which impacts may occur), shown in Figure 1-4, which includes the Plan Area (the area covered by the BDCP), upstream of the Delta, and the State Water Project/Central Valley Project (SWP/CVP) Export Service Areas. Water quality conditions refer to the chemical and physical properties of the surface water in the study area.

Conveying, using, and disposing of water occurs in association with domestic, industrial, and agricultural uses. Natural and anthropogenic contaminants, or *constituents of concern*, can enter Delta waters from various point and nonpoint sources. Point sources are any discernible, confined and discrete conveyance, including any pipe, ditch, channel, tunnel, conduit, or well from which pollutants (constituents of concern) are or may be discharged (Clean Water Act [CWA], Section 502[14]), and include treated water from industrial and municipal facilities, or points of agricultural discharge. The term *nonpoint source* is defined to mean any source of water pollution that does not meet the legal definition of *point source* in Section 502(14) of the CWA and includes urban and irrigation runoff. In the case of nonpoint sources, constituents of concern may enter receiving waters at multiple discrete and diffuse points throughout a watershed (i.e., not traceable to a single point). Daily tidal action has a major water quality influence from the high salinity of the Pacific Ocean and specific salinity constituents (e.g., sodium, potassium, chloride) transported inland to the Delta through the San Francisco Bay.

Temperature, pH, dissolved oxygen (DO), nutrients, and concentrations of other various constituents such as methylmercury and total organic carbon (TOC) can be affected by tidal marsh and floodplain habitats, especially when marsh waters are exchanged with other Delta waters both upstream and downstream of the tidal marsh/floodplain habitats. Because the primary concern of water temperature is effects on fish and aquatic organisms, temperature is addressed in Chapter 11, *Fish and Aquatic Resources.*

8.1.1 Affected Environment

For the purposes of characterizing the existing water quality conditions and evaluating the consequences of implementing the project alternatives on surface water quality, the affected environment is defined as anywhere an effect could occur, which includes but is not necessarily limited to the statutory Delta, Suisun Bay and Marsh, and areas to the north and south of the Delta, which are defined in various parts of this chapter as Upstream of the Delta and the SWP/CVP Export Service Areas, as shown in Figure 1-4. When compared to the watershed boundaries, it is noted that the affected environment falls primarily within the Sacramento and San Joaquin River watersheds.

This section identifies the watershed factors that affect water quality, the water quality standards applicable to the affected environment, and the known impairments (i.e., CWA Section 303[d], the primary constituents of concern in these areas, the regulatory framework, and the key water quality monitoring stations). Finally, water quality data from selected monitoring stations were reviewed for specific constituents in Section 8.1.3.

Because of the very distinct hydrologic and hydraulic characteristics (including the various inflow/outflow conditions) and specific operational details, the water quality in the Delta is described separately from the northern and southern parts of the study area. The Delta environment is much more complex and dynamic than the rest of the study area and requires a more detailed approach. Hence, the water quality conditions in the Delta were reviewed at a greater level of detail.

To characterize the existing water quality conditions in the Delta, it is important to evaluate the water quality of the primary inflows to and outflows from the Delta. Consequently, the water quality data compiled and described in this section include monitoring data from the three major rivers in the north (Sacramento, Feather, and American Rivers), the tributaries from the east (Cosumnes, Mokelumne, and Calaveras Rivers), the San Joaquin River from the south (including its major tributaries), San Francisco Bay water from the west, and agricultural runoff in the Delta. It also is important to characterize water quality at points where water is pumped out of the Delta (e.g., Harvey O. Banks Pumping Plant [Banks pumping plant], C. W. "Bill" Jones Pumping Plant (Jones pumping plant), Contra Costa Water District [CCWD] Pumping Plant #1 (CCWD pumping plant #1), North Bay Aqueduct Pumping Plant), and in areas south of the Delta where exported water is conveyed and stored. Examples of the latter include the Delta-Mendota Canal, the California Aqueduct, and San Luis Reservoir. Similarly, net outflow from the Delta occurs into Suisun Bay at Mallard Island, which is on the western boundary of the Delta and is the approximate boundary between limnetic (salinity of 0–0.5 parts per thousand [ppt]) and oligohaline (salinity of 0.5–5 ppt) areas during median flow conditions (Jassby 2008:4).

8.1.1.1 Organization of the Section

Sections 8.1.1.2 through 8.1.3.18 describe the Existing Conditions in the study area with respect to surface water quality and are organized in the following sequence.

- **Overview of the Sacramento and San Joaquin River Watersheds—**Brief overview of the watersheds and the Delta environment; location, physical description, and characteristics of the watersheds; climate; and hydrology.
- **Water Management and the State Water Project and Central Valley Project Systems—**Brief overview of the SWP and CVP, their key features, and the complex hydrodynamics of the study area.
- **Primary Factors Affecting Water Quality**—Brief discussion and listing of point and nonpoint pollutant sources, including historical and recent drainage from inactive and abandoned mines, industrial and municipal wastewater treatment plant (WWTP) discharges, agricultural and urban storm water runoff, recreational uses, and wildlife.
- **Beneficial Uses**—Brief overview of the designated beneficial uses in the study area, as defined in the Regional Water Quality Control Boards' (Regional Water Boards') water quality control plans (WQCPs or Basin Plans).
- **Water Quality Objectives and Criteria**—Brief discussion of regulatory water quality standards as described in the California Toxics Rule (CTR), water quality control plans, and California drinking water standards.

- **Water Quality Impairments**—Description of Section 303(d) list of impaired water bodies in the study area, existing Total Maximum Daily Loads (TMDLs), and descriptions of major ongoing water quality monitoring programs.
- **Water Quality Constituents of Concern**—Rationale for selecting specific water quality constituents of concern that are important to maintaining the water quality in the study area, and discussion of sensitive receptors affected by water quality.
- **Selection of Monitoring Stations for Characterization of Water Quality**—Brief description of the data sources, selection of monitoring stations to be analyzed, and data availability at the selected locations.
- **Regulatory Setting—**Brief description of federal, state, and regional/local regulatory agencies and the applicable guidance related to surface water quality.

Section 8.1.2, *Selection of Monitoring Locations for Characterization of Water Quality*, includes detailed discussions of the selected water quality constituents of concern in the study area. For each constituent, the discussion is organized by: (1) background information available in the literature; (2) importance of the constituent in the study area, including its potential effects on other resources; (3) Existing Conditions, including concentrations at various monitoring locations; and (4) spatial and temporal trends.

8.1.1.2 Overview of the Sacramento River and San Joaquin River Watersheds

Geographic Location and Physical Description

The Delta watershed includes the watersheds of the Sacramento and San Joaquin Rivers, the two largest rivers in the state. Together, the watersheds make up roughly one third of the state's land area. These rivers originate in the Coast Range, Cascade Range, and Sierra Nevada and flow through the Central Valley before entering the Delta. Following is a brief overview of watershed characteristics of the study area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, and Chapter 6, *Surface Water*.

The Delta is a complex system of stream channels, sloughs, marshes, canals, and islands in northern-central California at the confluence of the Sacramento and San Joaquin Rivers. The Delta covers 738,000 acres, which includes 59 islands, 1,100 linear miles of levees, hundreds of thousands of acres of farmland, and various habitat types (California Department of Water Resources 1995:91). The Delta lands and waterways support communities, agriculture, and recreation while providing essential habitat for a multitude of fish and wildlife species.

Delta inflow consists of runoff from the Sacramento River watershed, the San Joaquin River watershed, and the eastside tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Long-term average annual Delta inflow is approximately 22 million acre-feet (MAF), with a range of less than 8 MAF to more than 74 MAF (CALFED Bay-Delta Program 2000). Dry and critical year Delta inflow averages about 12 MAF annually under Existing Conditions (CALFED Bay-Delta Program 2000). As a contributor to the state's agricultural irrigation system and a major source of drinking water for two thirds of California's population, the Delta is a critical component of the state's water supply infrastructure.

Area Climate, Hydrology, and Watershed Characteristics

Sacramento River Watershed

The Sacramento River watershed drains the northern part of California's Central Valley. The Sacramento River, California's longest river, is approximately 447 miles long and drains approximately 27,000 square miles of land. Predominant land uses in the Sacramento River watershed are agriculture, natural (undeveloped), and urban areas. The major Sacramento River watershed drainages are the upper Sacramento, Feather, Yuba, and American Rivers (Figure 8-1).

The climate in the Sacramento River watershed is Mediterranean in character, typified by cool, wet winters and warm, dry summers. Daily high air temperatures in the Sacramento Valley range from around 45 degrees Fahrenheit (°F) in the winter to over 100°F in the summer. Average air temperatures in the mountainous regions of the watershed are typically 5–10° less than the temperature on the valley floor. Annual precipitation in the Sacramento River watershed ranges from 80 to 90 inches of primarily snowfall in the mountainous regions, to 41 inches of rain in Redding and 19 inches in Sacramento. Average annual precipitation for the entire watershed is approximately 36 inches. Most precipitation falls between November and April, with little or no precipitation falling between May and October (CALFED Bay-Delta Program 2000).

The majority of the runoff in the Sacramento River watershed is in the upper Sacramento River watershed and in the rivers flowing out of the western slope of the Sierra Nevada. Numerous reservoirs are located in the Sacramento River watershed. The major reservoirs in the Sacramento River watershed are Shasta Lake, Lake Oroville, and Folsom Lake. Trinity Lake lies in the coastal watershed, and water is diverted from it to the Sacramento River watershed. Total reservoir capacity in the Sacramento River watershed, including Trinity Lake, is approximately 16 MAF (California Department of Water Resources 2005).

An important characteristic of the Sacramento River watershed is that precipitation patterns are highly variable from year to year and within years. Figure 8-2 illustrates the precipitation pattern in the Sacramento Valley for water years from 1977 to 2008. Surface water supply is measured by water year. A *water year* is defined as the 12-month period of October 1 through September 30 of the following year. The water year is designated by the calendar year in which it ends (e.g., the year ending September 30, 2010, is called the *2010 water year*). The Sacramento River Index is a yardstick of northern California water supply or water availability from the Sacramento River watershed. The index is used to project the current water-year type and is based partially on the previous year's index and on the sum of the unimpaired runoff (in MAF) of four rivers: Sacramento River above Bend Bridge near Red Bluff, Feather River inflow to Lake Oroville, Yuba–River at Smartville, and American River inflow to Folsom Lake. Unimpaired runoff is an estimate of the runoff that would occur in a watershed if unaltered by upstream diversions, storage, or export/import of water to/from other watersheds. Based on the unimpaired runoff, the water year–type classifications are defined as follows.

- Wet: equal to or greater than 9.2 MAF.
- Above normal: greater than 7.8 and less than 9.2 MAF.
- Below normal: greater than 6.5 and less than or equal to 7.8 MAF.
- Dry: greater than 5.4 and less than or equal to 6.5 MAF.
- Critical: equal to or less than 5.4 MAF.

Relative water availability from the watershed is greatest in wet years and lowest in critical years. In the water years from 1977 to 2008, 10 years were wet (31%), six years were above normal (19%), two years were below normal (6%), seven years were dry (22%), and seven years were critical (22%), as shown in Figure 8-2.

San Joaquin River Watershed

The San Joaquin River watershed drains the southern part of the Central Valley. The San Joaquin River, California's second longest river, is approximately 330 miles long and drains approximately 15,200 square miles of land. Similar to the Sacramento River watershed, predominant land uses in the San Joaquin River watershed consist of agriculture, natural (undeveloped), and urban areas. The main San Joaquin River watershed drainages are the upper San Joaquin, Merced, Tuolumne, and Stanislaus Rivers (Figure 8-1).

The climate in the San Joaquin River watershed is similar to the Sacramento River watershed but is generally warmer and drier. Air temperatures in the city of Fresno range from 37°F in the winter to over 100°F in the summer. Annual precipitation in the San Joaquin Valley ranges from 8 to 12 inches of rain.

The warmer and drier conditions in the San Joaquin River watershed result in considerably less runoff compared to the Sacramento River watershed. The annual unimpaired runoff of the San Joaquin River watershed is approximately 5.5 MAF, with 60% of runoff occurring on the Merced, Tuolumne, and Stanislaus Rivers. Of the 5.5 MAF total unimpaired runoff, losses account for approximately 2.5 MAF via diversions for agricultural or municipal water supply, or losses to evaporative and groundwater infiltration, and 3 MAF flows into the Delta, past Vernalis (CALFED Bay-Delta Program 2000). Major reservoirs and impoundments in the San Joaquin River watershed are New Melones Lake, Hetch Hetchy, New Don Pedro Lake, Lake McClure, and Millerton Lake. Total reservoir capacity in the San Joaquin River watershed is approximately 11 MAF (California Department of Water Resources 2005). Figure 8-3 illustrates the highly variable precipitation pattern in the San Joaquin Valley for water years from 1977 to 2008. The water year–type classification used in Figure 8-3 is determined based partially on the previous year's index and on the sum of unimpaired flow (in MAF) at Stanislaus River below Goodwin Reservoir (inflow to New Melones Lake), Tuolumne River below LaGrange (inflow to New Don Pedro Lake), Merced River below Merced Falls (inflow to Lake McClure), and San Joaquin River inflow to Millerton Lake. The water year–type classifications are defined as follows.

- Wet: equal to or greater than 3.8 MAF.
- Above normal: greater than 3.1 and less than 3.8 MAF.
- Below normal: greater than 2.5 and equal to or less than 3.1 MAF.
- Dry: greater than 2.1 and equal to or less than 2.5 MAF.
- Critical: equal to or less than 2.1 MAF.

In the water years from 1977 to 2008, 12 years were wet (37%), four years were above normal (13%), one year was below normal (3%), five years were dry (16%), and 10 years were critical (31%), as shown in Figure 8-3.

East Side Tributaries Watersheds

The east side tributaries to the Delta include the Cosumnes, Mokelumne, and Calaveras Rivers. All three rivers drain the west slope of the Sierra Nevada. The Cosumnes River is approximately 50 miles long, drains approximately 725 square miles, and is the only river draining the west slope of the Sierra Nevada without a major dam. The Cosumnes River empties into the Mokelumne River just within the Delta. The Mokelumne River is approximately 95 miles long, drains approximately 2,140 square miles, and feeds both Pardee Reservoir and Camanche Reservoir. The Calaveras River is approximately 50 miles long, drains approximately 470 square miles, and feeds New Hogan Lake. The Calaveras River empties into the San Joaquin River north of Stockton. The climate and watershed characteristics of these drainages vary, but are generally similar to those described for the Sacramento and San Joaquin River watersheds above.

8.1.1.3 Water Management and the State Water Project and Central Valley Project Systems

The management of the SWP and CVP systems to meet water supply, flood management, and environmental obligations has a substantial effect on the quantity and timing of inflows to the Delta and on water quality in the study area. This section provides a brief overview of the SWP and CVP facilities and their operations. Following is a brief overview of surface water management in the study area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, and Chapter 6, *Surface Water,* which provide an overview of key facilities in the SWP and CVP systems.

State Water Project

The SWP's 33 water storage facilities, 600 miles of aqueducts, and multiple pumping plants and hydroelectric plants supply water to over 25 million Californians and to approximately 700,000 acres of farmland. Depending on the water-year type (i.e., available water supply) and demands, the SWP annually delivers up to about 3.7 MAF to meet contract demands. However, in drier water-year types when supply is limited, deliveries are considerably lower with an estimated 50% delivery reliability in any given water year of less than 2.7 MAF (California Department of Water Resources 2010). The primary objectives of the SWP are water supply; flood control; power generation; recreation, fish, and wildlife protection; and water quality improvements in the Sacramento–San Joaquin Delta.

Distribution of SWP water begins with releases from Oroville Dam into the Feather River, which flows into the Sacramento River at River Mile 80 and, ultimately, to the Delta. SWP pumps water into the North Bay Aqueduct from Barker Slough in the north Delta for use in Napa and Solano Counties. In the south Delta, water also is pumped into the South Bay Aqueduct to serve areas of Alameda County and Santa Clara County, and via the Banks pumping plant into the 444-mile-long California Aqueduct (California Department of Water Resources 2009a). The California Aqueduct conveys water south primarily to meet potable water demands of SWP contractors serving Central Valley and southern California counties, and to meet agricultural demands in the San Joaquin Valley and Tulare basin. The California Aqueduct delivers water to O'Neill Forebay and the San Luis Reservoir, a storage reservoir jointly owned by the SWP and CVP. Water is delivered to Santa Clara County and San Benito County from San Luis Reservoir via the Santa Clara and Hollister conduits. The Coastal Branch Aqueduct diverts water from the California Aqueduct to areas west in San Luis Obispo and Santa Barbara Counties. In southern California, water is delivered to the major storage reservoirs of Lake Perris, Silverwood Lake, Castaic Lake, and Lake Pyramid.

California Department of Water Resources (DWR), in its management of the SWP to supply the 29 contracting public agencies with water supply and provide flood control, additionally provide recreation opportunities, generate hydroelectric power, and protect fish and wildlife. These benefits of the SWP operations are achieved by increasing or decreasing upstream water releases, changing Delta pumping rates, or storing river flows south of the Delta at the San Luis Reservoir (Water Education Foundation 2004). During February through June, DWR reduces the ratio of water exports to inflows to reduce potential impacts on migrating salmon and spawning delta smelt, Sacramento splittail, and striped bass (Jassby et al. 1995). SWP facilities are operated to meet numerous water quality objectives, such as the X2 location objective. *X2* refers to the horizontal distance from the Golden Gate up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (Jassby et al. 1995). The location of X2 is important to both aquatic life and water supply beneficial uses. Chapter 5, *Water Supply*, describes the multiple water supply, flood control, and water quality targets that are used for SWP facilities management and operations.

Central Valley Project

The CVP annually delivers approximately 7 MAF of water for agricultural, urban, and wildlife use and is the largest water storage and delivery system in California (Bureau of Reclamation 2009a; CALFED Bay-Delta Program 2000). The CVP system consists of 20 dams and reservoirs, 11 hydropower plants, 500 miles of major canals, and additional related facilities (Bureau of Reclamation 2009a).

Transfer of water through the CVP system and the Delta begins with the release of water from reservoirs located on the Trinity, Sacramento, American, and Stanislaus Rivers (Bureau of Reclamation 2009a) Water released from Trinity and Shasta Dams flows into Keswick Reservoir and then is released into the Sacramento River from Keswick Dam at River Mile 303. A portion of the river's flow is diverted into the Tehama-Colusa and Corning Canals to irrigate the western side of the Sacramento Valley (Water Education Foundation 2002). The remainder of the Trinity and Shasta releases continue flowing south in the Sacramento River, combining with CVP releases from Folsom and Nimbus Dams at the confluence of the Sacramento and American Rivers and, ultimately, flowing to the Delta in the vicinity of Freeport. The Stanislaus River releases of water from New Melones Lake serve as a water source for CVP users in the Stanislaus River watershed and in the northern San Joaquin Valley (Bureau of Reclamation 2009a).

In the Delta, the released water is used to meet D-1641 Delta outflow and water quality objectives and to support export from the Delta at the Jones pumping plant into the Delta-Mendota Canal, which conveys water south for agricultural uses in the San Joaquin Valley. Water transported in the 117-mile Delta-Mendota Canal can be used as an irrigation supply, a source of San Luis Reservoir water, for managed wetland refuges, or as a replacement for upper San Joaquin River water used in the Friant-Kern and Madera Canal systems (Bureau of Reclamation 2009a). The San Luis Reservoir is an off stream storage reservoir that is used by both SWP and CVP to provide water to Central Valley and Bay Area users (Bureau of Reclamation 2009b). The Friant-Kern and Madera Canal systems originate at Friant Dam and transport upper San Joaquin River water approximately 152 miles south to Bakersfield and approximately 36 miles to the north, respectively (Water Education Foundation 2002). Additionally, CVP's Contra Costa Canal conveys Delta water from Rock Slough.

CCWD's Los Vaqueros Pipeline diverts water from Old River to the west to meet potable demands of Bay Area users served by CCWD (Bureau of Reclamation 2009a).

The Bureau of Reclamation (Reclamation) operates the CVP to meet the following objectives (Bureau of Reclamation 2009a).

- Regulate rivers and improve flood management and navigation.
- Provide water for irrigation and domestic use.
- Generate power.
- Provide recreation opportunities.
- Protect fish and wildlife.
- Improve water quality.

Reclamation's operation of the CVP facilities changes seasonally based on varying management objectives. During the winter and early spring months when flood management is a priority, CVP reservoirs are operated to store winter runoff (Water Education Foundation 2002). Releases during May through October are timed to meet a variety of water supply needs, manage water quality, and create available storage capacity for flood flows (Water Education Foundation 2002).

Hydrodynamics in the Delta

Delta hydrodynamics are a product of a complex interaction of tributary inflows, tides, in-Delta diversions, and SWP and CVP operations, including conveyance, pumping plants, and operations of channel barriers and gates designed to direct tributary inflows to certain regions of the Delta. Each region is affected differently by these variables, and the nature of the effect varies daily, seasonally, and from year to year, depending on the magnitude of inflows, the tidal cycle, and the extent of pumping at the SWP and CVP pumping plants.

For example, the SWP and CVP pumping plants can affect the direction of flow of water in the Delta channels, particularly during periods of low water flow and high export quantities. Normally, net flows in the Delta travel toward Suisun and San Francisco Bays. However, SWP and CVP pumping can cause the net flows within the interior south Delta to reverse, which causes more saline water to move farther inland (Bureau of Reclamation 2009a).

The Delta Cross Channel is a controlled diversion channel that transports Sacramento River water to Snodgrass Slough and then to the Mokelumne River, where it flows into the central and south Delta. Opening the Delta Cross Channel's gates generally can reduce salinity in some channels of the central and southern Delta, particularly during the summer months, through the transport of relatively low–salinity Sacramento River water into the Delta (Bureau of Reclamation 2009a).

Flow in the Delta channels can change direction as a result of tidal exchange, ebbing and flooding with the two tides per day, which is a major factor of Delta hydrodynamics. The daily, seasonal, and year-to-year differences in source water contributions to various locations throughout the Delta affect the water quality in the Delta, particularly with regard to salinity. Figure 8-4 and Figure 8-5 show the variations in maximum intrusion of chloride into the Delta since 1921, which demonstrate that variability and intrusion distance generally have been reduced following construction of the major storage reservoirs and implementation of Delta water management facilities and operations.

8.1.1.4 Primary Factors Affecting Water Quality

Primary factors affecting water quality in the study area include patterns of land use in the upstream watersheds and the Delta; SWP and CVP operations; and in-Delta/upstream activities and sources of pollutants. Point and nonpoint pollutant sources include historical and recent drainage from inactive and abandoned mines and related debris/sediment, industrial and municipal WWTP discharges, agricultural drainage, urban storm water runoff, atmospheric deposition, recreational uses, and metabolic waste (e.g., pathogens) from wildlife.

Figure 8-6 shows land uses and major point sources (consisting primarily of municipal WWTPs) and nonpoint sources (e.g., urban storm water runoff) of pollutants. Natural erosion and in stream sediments, atmospheric deposition, and geothermal inputs (CALFED Bay-Delta Program 2000) also affect Delta water quality. The magnitude of the effect of each of these sources is correlated with the relative contribution from each source and can differ, for different constituents or with conditions (e.g., hydrologic and climatic), during different times of a given year. The principal contaminants and conditions affecting water quality in the Delta are as follows (CALFED Bay-Delta Program 2000).

- Historical drainage and sediment discharged from upstream mining operations in the late 1800s and early 1900s has contributed metals, such as cadmium, copper, and mercury.
- Storm water runoff can contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (salts), petroleum products, oil and grease, and other chemical residues.
- Wastewater discharges from treatment plants can contribute salts, metals, trace organics, nutrients, pathogens, pesticides, organic carbon, personal care products, pharmaceuticals, and oil and grease.
- Agricultural irrigation return flows and nonpoint discharges can contribute salts (including bromide), organic carbon, nutrients, pesticides, pathogens, and sediment.
- Large dairies and feedlots can contribute nutrients, organic carbon, pathogenic organisms, hormones, and veterinary pharmaceuticals/antibiotics.
- Water-based recreational activities (such as boating) can contribute hydrocarbon compounds, nutrients, and pathogens.
- Atmospheric deposition can contribute metals, nutrients, pesticides, and other synthetic organic chemicals and may lower pH.
- Seawater intrusion can contribute salts, including bromide, which affect total dissolved solids (TDS) concentrations and can contribute to formation of unwanted chemical disinfection by-products (DBPs) in treated drinking water. Additionally, seawater can contribute sulfate, which can influence the methylation of mercury.
- Selenium can originate from the Sacramento River and San Joaquin River. Major sources of selenium include irrigation drainage from agricultural lands of the western San Joaquin Valley. Refinery wastewater discharges in North San Francisco Bay also serve as a source of selenium in the Delta.
- Organic loading from the San Joaquin River can contribute to low DO conditions in the Delta.

Both variations in watershed hydrology and SWP and CVP operations affect the variability of water quality in the study area; also both SWP/CVP and non-SWP/CVP water diversions reduce the amount of water available for dilution and assimilation of contaminant inputs and hydrodynamic conditions associated with channel flows and tidal action in the Delta. Water quality can vary seasonally in response to winter-spring runoff and summer-fall lower-flow periods or seasonal agricultural practices and cropping; water quality also can vary from year to year as a result of precipitation and snowpack levels in the upper watersheds and the resulting releases from upstream reservoirs for water supply, flood management, and environmental obligations (e.g., fish flows, Delta water quality objective compliance), operations of the Delta Cross Channel, and seasonal and annual variations in SWP and CVP pumping rates.

8.1.1.5 Beneficial Uses

Beneficial uses are designated for specific water bodies, either as existing or potential, by each Regional Water Board in their respective WQCPs or Basin Plans. Water bodies in the study area are used for many purposes as evidenced by the number of beneficial uses shown in Table 8-1. For water bodies where beneficial uses have not been identified specifically in a Basin Plan, the *tributary rule* allows a Regional Water Board to apply the designated beneficial uses that exist in the nearest downstream tributary. Established in the 1978 WQCP for the San Francisco Bay/Sacramento–San Joaquin Delta estuary (Bay-Delta WQCP), designated beneficial uses of Delta water remain unchanged in the 1991, 1996, and 2006 WQCPs. Additionally, the individual Basin Plans for the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) and Central Valley Regional Water Quality Control Board (Central Valley Water Board) identify beneficial uses of the Delta areas within their jurisdictions.

Table 8-1. Designated Beneficial Uses for Water Bodies in the Study Area

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Designated Beneficial Uses Common to Inland Waters in All Basin Plans and the Delta		
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including drinking water supply
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality, including mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible, including swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, and use of natural hot springs

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water or any likelihood of ingestion of water, including picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities
Commercial and Sport Fishing	COMM	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems, including preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), and wildlife water and food sources
Preservation of Biological Habitats of Special Significance	BIOL	Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection
Rare, Threatened, or Endangered Species	RARE	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant and animal species established under state or federal law as rare, threatened, or endangered
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration and other temporary activities by aquatic organisms, such as anadromous fish
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, mussels) for human consumption, commercial, or sport purposes
Additional Beneficial Uses of the Delta		
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, and wildlife (e.g., estuarine mammals, waterfowl, shorebirds)
Additional Beneficial Uses of Inland Waters (not common to all Basin Plans)		
Freshwater Replenishment[b]	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality
Hydropower Generation[c]	POW	Uses of water for hydropower generation
Aquaculture[c]	AQUA	Uses of water for aquaculture or mariculture operations, including propagation, cultivation, maintenance, and harvesting of aquatic plants and animals for human consumption or bait purposes
Inland Saline Water Habitat[d]	SAL	Uses of water that support inland saline water ecosystems, including preservation or enhancement of aquatic saline habitats, vegetation, fish, and wildlife, including invertebrates

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Limited Warm Freshwater Habitat[e]	LWRM	Waters that support warm water ecosystems that are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows, which result in extreme temperature, pH, and/or DO conditions; naturally reproducing finfish populations are not expected to occur in LWRM waters

Sources: Central Coast Regional Water Quality Control Board 2011; Central Valley Regional Water Quality Control Board 2009a; Los Angeles Regional Water Quality Control Board 1994; Santa Ana Regional Water Quality Control Board 2008; San Diego Regional Water Quality Control Board 2007; San Francisco Bay Regional Water Quality Control Board 2007; State Water Resources Control Board 2006.

[a] The names, abbreviations, and beneficial use descriptions are not identical in each Basin Plan.

[b] Potential beneficial use identified in Sacramento–San Joaquin, San Francisco Bay, Central Coast, Los Angeles, and San Diego Basin Plans.

[c] Potential beneficial use identified in Sacramento–San Joaquin, Central Coast, Los Angeles, Santa Ana, and San Diego Basin Plans.

[d] Potential beneficial use identified in Central Coast, Los Angeles, and San Diego Basin Plans.

[e] Potential beneficial use identified in Santa Ana Basin Plan only.

There are several additional beneficial uses in the Central Valley Water Board Basin Plan that are applicable to surface waters other than the Delta in the Sacramento River basin and south of the Delta export service area. Additionally, south-of-Delta exports are conveyed to service areas of SWP contractors that lie within the jurisdictions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards, which address several other beneficial uses that are unique to those geographic regions.

8.1.1.6 Water Quality Objectives and Criteria

It is important to define the terms *standards*, *numerical and narrative Basin Plan water quality objectives*, *CTR criteria*, and U.S. Environmental Protection Agency (USEPA) *recommended criteria* as they relate to the assessment of water quality. As defined by USEPA, water quality standards consist of: 1) the designated beneficial uses of a water segment; 2) the water quality criteria (referred to as *objectives* by the state) necessary to support those uses; and 3) an antidegradation policy that protects existing uses and high water quality. Each Regional Water Board's Basin Plan identifies numeric and narrative water quality objectives, together with the beneficial uses assigned to water bodies and the state antidegradation policy. By definition, Basin Plan objectives have gone through the standard-setting process, which includes public participation, consideration of economics, environmental review, and state and federal agency review and approval. Consequently, Basin Plan objectives are legally applicable and enforceable. In addition, the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) (State Water Resources Control Board 2006) identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives. The CTR criteria were established through the USEPA-led water quality standard–setting process. Hence, the CTR criteria, together with the beneficial uses assigned to water bodies and the state antidegradation policy, constitute additional water quality standards for the regions (beyond those specified in the Basin Plans). Finally, USEPA periodically recommends ambient water quality criteria to states for their consideration in adopting state standards. As stated by USEPA, the USEPA recommended criteria (also referred to as 304[a][1] criteria) "…are not regulations, and do not impose legally binding requirements on EPA, States, tribes or the public." Therefore, USEPA-recommended criteria and other nonenforceable guidance values are referred to as *advisory* when discussed in this chapter in order to distinguish them from adopted objectives and criteria.

Applicable ambient surface water quality criteria and objectives for the study area are contained in the following sources.

- CTR (criteria applicable to all surface waters in California).
- 2006 Bay-Delta WQCP (or the 1995 Bay-Delta WQCP)(objectives applicable to the Delta only, regulated through water rights conditions by the State Water Resources Control Board [State Water Board]).
- Central Valley Water Board and San Francisco Bay Water Board Basin Plans (objectives applicable to the Delta and other surface waters in the study area, regulated through point and nonpoint source controls).
- Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards (applicable to surface waters in the south-of-Delta areas served by SWP exports).

State objectives can be narrative or numeric. A narrative objective establishes a *desired level of protection* or describes a *favorable condition to be achieved* rather than defining a specific numerical concentration. An example of a narrative objective is "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses." A numeric objective defines a concentration that must not be exceeded for a parameter (e.g., 10 milligrams per liter [mg/L]). Along with the concentration value, numerical water quality objectives also typically specify an averaging period to which the concentration value applies to protect the beneficial use of interest. Averaging periods typically depend on the sensitivity of the use, such as a 1-hour averaging period for objectives designed to prevent acute toxicity in aquatic life, to longer averaging periods (e.g., 30-day, annual average) for less-sensitive effects (e.g., human health effects, industrial uses, agricultural crop production). The value of some numerical water quality objectives (primarily for aquatic life) depends on the prevailing ambient freshwater and saltwater salinity conditions. With regard to these objectives, the salinity conditions across the large majority of the Delta are sufficiently low that the Delta channels are subject to the freshwater regulatory water quality criteria/objectives. However, tidal influence and associated saltwater intrusion can result in salinity concentrations in areas of the west Delta that require regulation with saltwater criteria/objectives. Salinity standards themselves are discussed in the section below on the Bay-Delta WQCP. Appendix 8A, *Water Quality Criteria and Objectives*, summarizes the specific water quality criteria/objectives that apply to the Delta.

California Toxics Rule

CTR criteria are established only for aquatic life and human health protection. CTR criteria for aquatic life protection for some constituents (most metals, cyanide, various organic compounds) are specified for freshwater and saltwater conditions. The CTR states that the salinity characteristics (freshwater versus saltwater) of the receiving water must be considered in determining the applicable criteria. Freshwater criteria apply to waters with salinity equal to or less than 1 ppt at least 95% of the time. Saltwater criteria apply to waters with salinity equal to or greater than 10 ppt at least 95% of the time. For waters with salinity between these two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the applicable criteria are the lower of the freshwater or saltwater values for each substance. CTR criteria for the protection of human health are specified that apply to any receiving water where human consumption of water and/or organisms occurs. Refer to Section 8.2, *Regulatory Setting*, for additional detail about the CTR and other applicable water quality regulations. Appendix 8A, *Water Quality Criteria and Objectives*, provides the applicable CTR criteria specified for aquatic life protection and human health protection.

Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

The Bay-Delta WQCP (State Water Resources Control Board 2006) identifies the beneficial uses of the Bay–Delta to be protected, the water quality objectives for reasonable protection of beneficial uses, and a program of implementation for achieving the water quality objectives. Unless otherwise indicated, water quality objectives cited for a general area, such as for the south Delta, are applicable for all locations in that general area, and specific compliance locations are used to determine compliance with the cited objectives within the area. Numeric objectives for chloride are included for the protection of municipal and industrial water supply beneficial uses. Objectives for EC) are included for multiple western, interior, and south Delta compliance locations for the protection of agricultural supply beneficial uses. Salinity objectives also are specified for fish and wildlife protection in the form of EC objectives for eastern and western locations in Suisun Marsh, a narrative salinity objective for brackish tidal marshes of Suisun Bay, and the X2 standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 ppt. In general, the chloride and EC objectives (and Delta inflow/outflow operational objectives) vary depending on the month of the year and the water-year type. EC and DO objectives are included for the protection of fish and wildlife beneficial uses. Additionally, Delta inflow and outflow operational objectives (Delta outflow, river flows, export limits, and Delta Cross Channel gate operations) are specified for the protection of fish and wildlife beneficial uses. Compliance with salinity objectives in particular is largely dependent on Delta inflows and outflows. The current water quality objectives under this plan are included in Appendix 8A, *Water Quality Criteria and Objectives*.

The State Water Board is now in the midst of a four-phased process of developing and implementing updates to the Bay-Delta WQCP and flow objectives for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed. Phase 1 of this work involves updating San Joaquin River flow and southern Delta water quality requirements included in the Bay-Delta WQCP. Phase 2 involves other comprehensive changes to the Bay-Delta WQCP to protect beneficial uses not addressed in Phase 1. Phase 3 involves changes to water rights and other measures to implement the changes to the Bay-Delta WQCP from Phases 1 and 2. Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay-Delta WQCP updates (State Water Resources Control Board 2013).

Water Quality Control Plan for the Sacramento and San Joaquin River Basins

The Basin Plan for the Sacramento and San Joaquin Rivers defines the beneficial uses, water quality objectives, implementation programs, and surveillance and monitoring programs for waters of the Sacramento and San Joaquin River basins. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies, or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, EC, TDS, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. Narrative water quality objectives also serve as the basis for the development of detailed numerical objectives. The narrative water quality objectives and numeric freshwater criteria/objectives adopted for the Delta are included in Appendix 8A, *Water Quality Criteria and Objectives* (Regions 2 and 5).

Water Quality Control Plan for San Francisco Bay

The Basin Plan for the San Francisco Bay basin (San Francisco Bay Water Board 2007) is similar to the Basin Plan for the Central Valley and defines numerical and narrative water quality objectives for San Francisco Bay (including San Pablo Bay) and portions of the west Delta. The designated beneficial uses for the Delta are consistent with the Central Valley Basin Plan. This Basin Plan contains both freshwater and saltwater criteria for several priority pollutant trace metals. Freshwater objectives apply to waters lying outside the zone of tidal influence and having salinities lower than 5 ppt at least 75% of the time. Saltwater objectives apply to waters with salinities greater than 5 ppt at least 75% of the time. For waters with salinities between the two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the objectives are the lower of the freshwater or saltwater objectives, based on ambient hardness, for each substance. Appendix 8A, *Water Quality Criteria and Objectives*, provides the numeric freshwater and saltwater objectives adopted for the Delta.

Water Quality Control Plans Applicable to the State Water Project South-of-Delta Service Area

The Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards similarly define beneficial uses and numeric and narrative water quality objectives for inland and coastal waters and other water bodies in the service areas of SWP contractors that use water from the California Aqueduct and are located generally south of the Central Valley and in the central and southern California coastal counties. In general, the narrative and numeric water quality objectives for inland waters established in these Basin Plans are similar to the Central Valley and San Francisco Bay Regions. However, because salinity is a primary water quality constituent of concern in the inland and coastal counties of arid southern California, the Basin Plans for these regions all contain specific numeric water quality objectives for salinity constituents (e.g., TDS, hardness, sodium, chloride, sulfate) for the protection of municipal/domestic and agricultural water supply beneficial uses. The established salinity-based objectives for specific water bodies in these Basin Plans can vary based on specific base-level conditions.

Water Quality Control Plans Applicable to Suisun Marsh

Suisun Marsh is located at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin Rivers and is not within the statutory Delta. Suisun Marsh consists of tidal wetlands, sloughs, managed diked wetlands, managed seasonal wetlands, and upland grasslands. The marsh contains approximately 59,000 acres of marsh, managed wetlands, and adjacent grasslands, plus 30,000 acres of open-water areas. Most of the managed wetlands are within levee systems with a majority owned by private duck hunting clubs. About 14,000 acres are state-owned and managed by the California Department of Fish and Wildlife (CDFW), and about 1,400 acres on channel islands are federal lands. Elevation and salinity are the principal factors controlling the distribution of tidal marsh plants in the marsh. Within the diked wetlands, water diversion and release operations are managed to maximize the production of aquatic vascular plants that traditionally have been considered important for wintering waterfowl.

The regulatory framework for managing water quality conditions in Suisun Marsh began in the 1970s with the development of the Suisun Marsh Protection Plan by the Bay Conservation and Development Commission and the adoption of salinity objectives for marsh channels in the 1978 Bay-Delta WQCP to protect the beneficial uses for fish and wildlife. The State Water Board water rights decision D-1485, applicable to DWR and Reclamation for the management of SWP and CVP operations, was adopted with provisions to meet the Suisun Marsh salinity objectives. DWR's 1984 Plan of Protection for Suisun Marsh was developed to meet the D-1485 requirements and outlined a staged implementation for a combination of proposed physical salinity management initial facilities, monitoring, a wetlands management program for marsh landowners, and supplemental releases of water from SWP and CVP reservoirs. In 1987, federal and state agencies adopted the Suisun Marsh Preservation Agreement (SMPA) to mitigate impacts on marsh salinity from the SWP, CVP, and other upstream diversions. The SMPA identified the schedule for construction of large-scale facilities in Suisun Marsh that would enable the salinity objectives to be met. The 1991 Bay-Delta WQCP increased to seven the number of locations in the marsh where numerical salinity objectives were to be met. The 1994 Principles of Agreement on Bay-Delta Standards (Bay-Delta Accord that formed CALFED), the 1995 Bay-Delta WQCP, and the adoption of State Water Board water rights decision D-1641 in 1999 all resulted in refinements to the Suisun Marsh salinity standards, added narrative salinity objectives for the tidal marshes of the surrounding Suisun Bay, and mandated the formation of a Suisun Marsh Ecological Work Group that would provide recommendations for water quality objectives to improve conditions for beneficial uses (wildlife habitat; rare, threatened and endangered species; and estuarine habitat) and recommend future research and monitoring needs for the marsh. Because evidence showed a potential for actions to meet the salinity objectives at two compliance stations within the marsh might cause harm to the beneficial uses they were intended to protect, the State Water Board in D-1641 did not require that DWR and Reclamation attain the objectives at these stations. The salinity objectives for the marsh remained unchanged in the 2006 Bay-Delta WQCP, but it notes that salinity objectives will be finalized, including adoption of numerical objectives for brackish marshes in Suisun Bay and other locations (if necessary), by 2015 and following development and implementation of a comprehensive Suisun Marsh Plan. Federal and state agencies recently completed environmental compliance documentation for the Suisun Marsh Plan (Bureau of Reclamation et al. 2011), which assesses a comprehensive 30-year plan designed to address use of resources within about 52,000 acres of wetland and upland habitats in the marsh, restoration of tidal wetlands, and the enhancement of managed wetlands and their functions.

The Suisun Marsh Salinity Control Gates (SMSCG) were constructed on Montezuma Slough near Collinsville and began operating in late 1988. The gates are operated periodically from September to May to meet the salinity standards of the 1995 Bay-Delta WQCP and D-1641 requirements. The SMSCG operation acts to restrict the inflow of high-salinity flood-tide water from Grizzly Bay into the marsh but allow passage of freshwater ebb-tide flow from the mouth of the Delta. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher-salinity water in Montezuma Slough. Because the SMSCG operations have been more effective than anticipated, and as a result of additional freshwater Delta outflows required by the 1995 Bay-Delta WQCP, other previously proposed large physical facilities to promote further salinity controls in the marsh have not been implemented. The SMSCG are operated only as needed and generally do not operate from June through August.

Other Water Quality Plans

The State Water Board has begun development of a statewide mercury regulatory program to address reservoirs on the state's Section 303(d) list for mercury. The plans are at the scoping level as of first quarter 2012.

In 2005, the State Water Board directed the San Francisco and Central Valley Water Board to address the public health impacts of mercury in fish. In response, the Central Valley Basin Plan requires all entities subject to controlling methylmercury in the Delta and Yolo Bypass to participate in a program to reduce human exposure to mercury through eating fish. The Mercury Exposure Reduction Program (MERP) was developed to meet this objective. The primary goals of the Delta MERP are to increase understanding of contaminants in fish and reduce exposure to mercury among people who eat fish from the Delta.

The Delta Regional Monitoring Program (RMP) is currently under development by the Central Valley Water Board as of August 2013. The RMP was initiated by the Central Valley Water Board to establish a system for coordinating among the many agencies and groups that monitor water quality, flows, and ecological conditions in the Delta, whereby all data are synthesized and assessed on a regular basis, with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of contaminants and contaminant effects in the Delta.

California Drinking Water Standards Incorporated by Reference in Basin Plans

Both the Central Valley and San Francisco Bay Basin Plans incorporate by reference the California Department of Public Health (DPH) numerical drinking water maximum contaminant levels (MCLs). The incorporation of the MCLs, which apply to treated drinking water systems regulated by DPH, makes the MCLs also applicable to ambient receiving water with respect to the regulatory programs administered by the Regional Water Boards. DPH establishes state drinking water standards, enforces both federal and state standards, administers water quality testing programs, and issues permits for public water system operations. The drinking water regulations are found in Title 22 of the California Code of Regulations (CCRs). The state drinking water standards consist of primary and secondary MCLs. Primary MCLs are established for the protection of environmental health, and secondary MCLs are established for constituents that affect the aesthetic quality of drinking water, such as taste and odor. The incorporation by reference of the MCLs in Basin Plans is meant to ensure, to the extent possible, that adequate source water quality is maintained to support the domestic and municipal water supply beneficial use, particularly from constituents that WWTPs are not typically designed to remove. The state primary and secondary MCLs applicable to the Central Valley and San Francisco Bay Basin Plans are provided in Appendix 8A, *Water Quality Criteria and Objectives*.

8.1.1.7 Water Quality Impairments

Water Quality–Limited Water Bodies, Watershed Monitoring Programs, and Total Maximum Daily Loads

Constituents of concern in the study area have been identified through ongoing regulatory, monitoring, and environmental planning processes. Important programs are CALFED, the Basin Plan functions of the Central Valley and San Francisco Bay Water Boards, Bay-Delta planning functions of the State Water Board, and the CWA Section 303(d) listing process for state water bodies that do not meet applicable water quality objectives.

The CALFED Bay-Delta Program was established in 1995 to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta System. Senate Bill 1653 established the California Bay-Delta Authority to act as the governance structure, as of January 1, 2003, and is housed within the California Resources Agency.

Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water quality–limited segments of rivers and other water bodies under their jurisdiction. Listed waters are those that do not meet water quality standards even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that action plans, or TMDLs, be developed to monitor and improve water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs can lead to more stringent National Pollutant Discharge Elimination System (NPDES) permits (CWA Section 402).

The State Water Board and USEPA have approved TMDLs for organic enrichment/low DO and methylmercury in the Delta, and for salt and boron in the San Joaquin River at Vernalis. TMDLs for other constituents remain under planning or development. Additionally, the San Francisco Bay Water Board is currently developing a TMDL for Suisun Marsh to address impairment by methylmercury, DO, and nutrient enrichment (San Francisco Bay Regional Water Quality Control Board 2012). Although Suisun Marsh is not within the officially designated Delta, the mercury and salinity impairments are primarily associated with loading from the Delta. Low DO is associated with seasonal organic loading from wetland and water management systems within the marsh. The salinity impairment was identified in the 1970s as an issue of changing marsh vegetation and potential adverse effects on marsh vegetation that was important to ducks as feed. The SMSCG were installed in Montezuma Slough in 1988 to provide the means to control salinity intrusions from Suisun Bay during the periods of low Delta outflow.

The State Water Board compiled the 2010 Section 303(d) list of impaired waters based on recommendations from the Regional Water Boards and information solicited from the public (and other interested parties). In October 2011, USEPA gave final approval to the list. Table 8-2 lists the constituents identified in the Section 303(d) list for impaired Delta waters (State Water Resources Control Board 2011).

1 **Table 8-2. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta**

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Boron	Central Valley	Agriculture	Exp
Chlordane	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, W
Chloride	Central Valley	Source unknown	TomP
Chlorpyrifos	Central Valley	Agriculture, urban runoff/ storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Duck, Five, French, MokR, Morm, Mosh, OldR, Pix
Copper	Central Valley	Resource extraction	MokR
DDT	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, S, E, W, NW, C, Exp, Stk
Diazinon	Central Valley	Agriculture, urban runoff/storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Five, French, Mosh, Pix
Dieldrin	San Francisco Bay	Nonpoint source	N, W
Dioxin compounds	Central Valley and San Francisco Bay	Source unknown, atmospheric deposition	W, Stk
Disulfoton	Central Valley	Agriculture	Pix
E. coli	Central Valley	Source unknown	E, French, Pix
Invasive species	Central Valley and San Francisco Bay	Source unknown, ballast water	N, S, E, W, NW, C, Exp, Stk
Furan compounds	Central Valley and San Francisco Bay	Contaminated sediments, atmospheric deposition	Stk
Group A pesticides[a]	Central Valley	Agriculture	N, S, E, W, NW, C, Exp, Stk
Mercury	Central Valley and San Francisco Bay	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	N, S, E, W, NW, C, Exp, Stk, CalvR, MokR, Mosh
Pathogens	Central Valley	Recreational and Tourism Activities (nonboating), Urban Runoff/Storm Sewers	Stk, CalvR, Five, Morm, Mosh, Walk
PCBs	Central Valley and San Francisco Bay	Source unknown	W, N, Stk
Unknown toxicity[b]	Central Valley	Source unknown	N, S, E, W, NW, C, Exp, Stk, French, MokR, Morm, Pix
EC	Central Valley	Agriculture	S, W, NW, Exp, Stk, OldR, TomP
Organic enrichment/ low DO	Central Valley	Municipal point sources, urban runoff/storm sewers	Stk, CalvR, Five, MidR, MokR, Morm, Mosh, OldR, Pix, TomP
Sediment toxicity	Central Valley	(Not specified)	French
Selenium	San Francisco Bay	Refineries, invasive species, natural sources	W
TDS	Central Valley		S, OldR
Zinc	Central Valley	Resource extraction	MokR

Source: State Water Resources Control Board 2011.

Notes: DDT = dichlorodiphenyltrichloroethane, PCB = polychlorinated biphenyls, EC = electrical conductivity, DO = dissolved oxygen, TDS = total dissolved solids.

Delta Locations: C = Central, E = East, Exp = export area, N = north, NW = northwest, S = south, Stk = Stockton Deep Water Ship Channel, W = west (includes Central Valley list and San Francisco Bay list for Bay-Delta category).

Specific Delta Waterways: CalvR = Calaveras River, Duck = Duck Slough, Five = Five Mile Slough, French = French Camp Slough, MidR = Middle River, MokR = Mokelumne River, Morm = Mormon Slough, Mosh = Mosher Slough, OldR = Old River, Pix = Pixley Slough, TomP = Tom Paine Slough, Walk = Walker Slough.

[a] Group A pesticides include aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, benzene hexachloride (BHC; including lindane), endosulfan, and toxaphene.

[b] Toxicity is known to occur, but the constituent(s) causing toxicity is unknown.

There are several ongoing watershed-monitoring programs in the study area. These monitoring programs are associated with Section 303(d) TMDL programs, the State Water Board Surface Water Ambient Monitoring Program, and numerous other efforts of local governments and public/private entities.

Section 303(d) requires that states evaluate and rank water quality impairments that cannot be resolved through point source controls and, in accordance with the priority ranking, the TMDL for those pollutants the USEPA identifies under Section 304(a)(2) as suitable for such calculation. The TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. The TMDL is the amount of loading that the water body can receive and still meet water quality standards. The TMDL must include an allocation of allowable loadings to point and nonpoint sources, with consideration of background loadings. Table 8-3 summarizes the TMDLs that have been completed or are being developed for Section 303(d) listed constituents in the Delta, and the portion of the study area in the Sacramento and San Joaquin River basins (Central Valley Regional Water Quality Control Board 2009b).

Table 8-3. Summary of Completed and Ongoing Total Maximum Daily Loads in the Bay-Delta and Sacramento and San Joaquin River Portions of the Study Area

Pollutant/Stressor	Water Bodies Addressed	TMDL Status
Chlorpyrifos and diazinon	Sacramento County Urban Creeks	TMDL report completed—September 2004 State-Federal approval—November 2004
Chlorpyrifos and diazinon	Lower San Joaquin River	TMDL report completed—October 2005 State-Federal approval—December 2006
Chlorpyrifos and diazinon	Sacramento and San Joaquin Rivers and Delta	TMDL report completed—June 2006 State-Federal approval—October 2007
Chlorpyrifos and diazinon	Sacramento and Feather Rivers	TMDL report completed—May 2007 State-Federal approval—August 2008
Chlorpyrifos and diazinon	Lower San Joaquin River	TMDL report completed—October 2005 State-Federal approval—December 2006
DO	Stockton Deep Water Ship Channel	TMDL report completed—February 2005 State-Federal approval—January 2007
Mercury/methylmercury	Delta	TMDL report completed—April 2010
Mercury/methylmercury	Reservoirs	Ongoing
Pathogens	Tributaries affected by city of Stockton urban runoff	Ongoing
Pesticides	Basin-wide	Ongoing
Organochlorine pesticides	Specific Sacramento and San Joaquin River tributaries; Delta	Ongoing
Salt and Boron	San Joaquin River at Vernalis	TMDL report completed—October 2005 State-Federal approval—February 2007
Selenium	San Joaquin River at Vernalis	TMDL report completed—August 2001 State-Federal approval—March 2002

Source: Central Valley Regional Water Quality Control Board 2009b.
Notes: DO = dissolved oxygen; TMDL = Total Maximum Daily Load.

Table 8-4 summarizes only the total number of Section 303(d) listed water bodies in the regions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards where SWP south-of-Delta exports are conveyed. This information is presented at a lesser level of detail than for the Delta and Sacramento–San Joaquin regions because the effects of storage and conveyance of Delta export water in the southern SWP service areas to the large majority of these listed water bodies are only indirect or nonexistent. Moreover, not all of the Section 303(d)–listed water bodies in these regions necessarily occur in the SWP service areas because the SWP service areas do not cover the entire regions.

Table 8-4. Clean Water Act Section 303(d) Listed Water Bodies in Regions of the Study Area Served by SWP South-of-Delta Exports

	Regional Water Board				
Pollutant	San Francisco	Central Coast	Los Angeles	Santa Ana	San Diego
Hydromodification			10		
Mercury	36	6	11	2	2
Other metals	27	44	142	24	159
Miscellaneous	17	147	52	11	36
Nuisance		3	27		14
Nutrients	15	321	183	29	179
Other inorganics	2		39		14
Other organics	64	11	102	10	18
Pathogens	32	451	171	44	324
Pesticides	95	142	187	16	32
Salinity	1	194	72	2	46
Sediment	10	168	23	10	20
Toxicity	7	105	49	8	109
Trash	27		87		7

Source: State Water Resources Control Board 2011.

8.1.1.8 Water Quality Constituents of Concern

Constituents that are of concern in the study area are those that, at elevated concentrations, have the potential to adversely affect or impair one or more beneficial uses (Table 8-1), such as the constituents identified from the Section 303(d) listing process described above (Tables 8-2 and 8-4).

Salinity is an important parameter of concern for the Delta that reflects the total ionic content of the water, ranging from very low levels deemed freshwater to the high salinity content of seawater. Chloride, bromide, and boron are specific ions that contribute to overall salinity and are constituents of concern. Salinity can affect multiple beneficial uses, including defining the types and distribution of aquatic organisms that are adapted to freshwater versus brackish, or saline, water conditions in the Delta.

Other constituents of concern for the Delta in particular are of importance to municipal water suppliers, including organic carbon (total and dissolved) and bromide, which are precursors for the formation of DBPs such as trihalomethanes (THMs), haloacetic acids (HAAs), bromate, chlorite, and nitrosamines at treated drinking water treatment processes. The DBPs mentioned are of concern because they are known or suspected human carcinogens when consumed at elevated concentrations over many years. Pathogens are of importance to municipal water suppliers as well as recreational uses.

In addition, elevated nutrient concentrations can affect municipal water suppliers that store diverted Delta water in reservoirs. Elevated nutrient levels contribute to algae growth and affect the taste and odor of treated water, filter clogging at WWTPs, and increased levels of organic carbon. Increased salinity concentrations also can alter the taste of finished drinking water.

Constituents of concern to agricultural users in the study area include boron and salinity. Many crops are sensitive to these constituents, which can affect their yield.

Numerous constituents, including temperature, turbidity and suspended sediment, DO, pesticides, herbicides, nutrients, and trace metals, can cause adverse effects on aquatic life in the study area. Trace metals, pesticides, and herbicides can be toxic to aquatic life at relatively low concentrations. Temperature and DO are of concern because the Delta serves as a migration and rearing corridor for anadromous salmonids, which are sensitive to these parameters. Because the primary concern of water temperature is effects on fish and aquatic organisms, temperature is addressed in Chapter 11, *Fish and Aquatic Resources.* Excess nutrients can cause blooms of nuisance algae and aquatic vegetation, and their decay can result in depleted DO.

Finally, an emerging class of constituents of concern is endocrine-disrupting compounds (EDCs), pharmaceutical and personal care products (PPCPs), and nitrosamines. EDCs and PPCPs are thought to have potential to cause adverse effects on aquatic resources, and their potential presence in drinking water supplies has received significant attention (World Health Organization 2002; U.S. Geological Survey 2002). Nitrosamines have long been suspected carcinogens, but their more recent discovery as a DBP, along with lower detection limits for the analytical methods used to measure them, has spurred more attention in recent years.

As noted in Table 8-2, the entire Delta is identified on the Section 303(d) list as impaired by unknown toxicity. Aquatic toxicity refers to the mortality of aquatic organisms or sublethal (e.g., growth, reproductive success) effects. Aquatic toxicity can be caused by any number of individual constituents of concern, or through additive and synergistic effects attributable to the presence of multiple toxicants. No TMDLs have been developed for the Delta to address the sources of toxicity, identify alternatives to reduce toxicity, or identify the allocation of the allowable loading of constituents that would result in achieving the Basin Plan narrative toxicity objective that forms the basis for the Section 303(d) listing. Because unknown toxicity is a primary concern for fish and other aquatic organisms, Chapter 11, *Fish and Aquatic Resources*, addresses the subject in detail.

In light of these issues, the constituents of concern identified in Table 8-5 are addressed in detail for the purposes of characterizing existing water quality in the study area (Section 8.1.3, *Existing Surface Water Quality*) and to support the water quality impact assessments. Table 8-5 also relates the constituents of concern to the various receptors in the study area that could be adversely affected by their concentrations. For purposes of this characterization, the receptors are categorized by the designated beneficial uses specified in the Bay-Delta WQCP. The constituent-specific sections described subsequently (Section 8.1.3) characterize the potential effects on beneficial uses and various receptors, including known information regarding specific locations in the Delta most affected by the constituents.

8.1.2 Selection of Monitoring Locations for Characterization of Water Quality

8.1.2.1 Water Quality Monitoring Programs and Sources of Data

In compiling water quality data for the constituents of concern (Table 8-5), data sets from the following monitoring programs/entities were obtained through the Bay-Delta and Tributaries Project (BDAT) database for the period from 1990 through 2009 (Bay Delta and Tributaries Project 2009). This effort began in early 2010, when data more recent than 2009 were not available. Revision of the data summarized below to account for more recent monitoring data was not considered necessary because there was no reason to expect that water quality conditions as represented by these monitoring databases would be substantially changed relative to the data already collected. Also, any differences would not be of a magnitude that would alter the nature of the characterization or the assessment in any substantial way.

- California National Water Information System Water Quality Data (U.S. Geological Survey [USGS]).
- Environmental Monitoring Program (DWR) (continuous and discrete data).
- Municipal Water Quality Investigations Program data (DWR).
- Surface Water Ambient Monitoring Program (State Water Resources Control Board and Regional Water Boards).

BDAT contains environmental data concerning the Bay-Delta and provides public access to those data. More than 50 organizations voluntarily contribute biological, water quality, meteorological, and other data to this database. In the event the monitoring programs listed above, as accessed through BDAT, did not provide data for all the constituents of interest, additional data were obtained from one or more of the following monitoring programs/databases to provide a more comprehensive characterization of Delta water quality.

- California Data Exchange Center (DWR).
- Interagency Ecological Program (multiagency).
- National Water Information System (USGS).
- San Francisco Estuary Institute ([SFEI] multi-agency in Bay Area).
- Sacramento River Coordinated Monitoring Program (Sacramento Stormwater Quality Partnership and the Sacramento Regional County Sanitation District (SRCSD)).
- Sacramento River Watershed Program (nonprofit 501[c][3] organization).
- Water Data Library (DWR).

8.1.2.2 Surface Water Quality Monitoring Locations

Based on data availability, data continuity, and geographic location, a total of 20 water quality monitoring stations were selected to characterize the water quality conditions in the study area (Figure 8-7). Because of the complexity of the Delta environment, a detailed characterization of water quality was necessary for the statutory Delta to represent the effects of water quality on the broad beneficial use categories (e.g., agriculture, aquatic life, recreation) and more specific issues such as major water diversion locations. For example, major water diversions include CCWD's three intakes at Rock Slough, Old River, and Victoria Canal; the North Bay Aqueduct; Jones and Banks pumping plants; seasonal Antioch and Mallard Slough diversions; and the City of Stockton's new diversion from the central Delta. The following section provides a brief illustration of how the data from these stations were used to represent various parts of the study area. Table 8-6 presents the specific reasons for selecting these locations and describes the spatial area of the study area for which specific stations provide adequate representation.

North of Delta

The hydrology north of the Delta is dominated by three major rivers—the Sacramento, Feather, and American. To characterize the water quality for the area north of the Delta, it is important to review the water quality entering these three rivers from their major reservoirs (Shasta Lake, Lake Oroville, and Folsom Lake, respectively). For the purpose of this assessment, the water quality of the area north of the Delta is represented by locations downstream of these three lakes, as well as a monitoring location at the Sacramento River at Verona (immediately downstream of the confluence of the Feather and Sacramento Rivers, representing the water quality of the combined flow after mixing) Figure 8-7 shows the selected locations.

- Sacramento River at Keswick.
- Feather River at Oroville.
- American River at the E. A. Fairbairn Water Treatment Plant (WTP).
- Sacramento River at Verona.

Because organic carbon data were not monitored at the Verona location, data from a monitoring location approximately 9 miles downstream of the Verona location (Sacramento River at Vietnam Veterans Memorial Bridge [Interstate 5] [Veterans Bridge]) were reviewed and analyzed for organic carbon. Water quality downstream of the confluence of American and Sacramento Rivers is represented by the monitoring station at Hood, which is addressed in Section 8.1.2.3, *Delta Source Waters*.

Table 8-5. Receptors Affected by Water Quality—Characterized by the Designated Beneficial Uses of the Study Area

Constituent	Freshwater Replenishment	Municipal and Domestic Supply and Groundwater Recharge	Agricultural Supply	Industrial Process Supply	Recreation		Shellfish Harvesting and Aquaculture	Commercial/ Sport Fishing	Freshwater Habitat		Migration/ Spawning	Estuarine Habitat	Wildlife Habitat	Endangered Species and Areas of Biological Significance
					Contact	Non-Contact			Warm	Cold				
Physical Parameters														
Temperature		X					X	X	X	X	X	X		X
Turbidity/suspended solids	X	X		X	X	X			X	X	X	X		X
Inorganic parameters														
Salinity (EC/TDS)	X	X	X	X			X	X	X	X	X	X	X	X
Bromide	X	X												
Chloride	X	X	X	X			X	X	X	X	X	X	X	X
Boron	X		X											
Organic carbon	X	X												
Ammonia (nitrogen)		X					X	X	X	X	X	X		X
Other nutrients (nitrogen, phosphorus)	X	X					X	X	X	X	X	X	X	X
DO							X	X	X	X	X	X		X
Trace Metals														
Mercury	X	X					X	X	X	X	X	X	X	X
Selenium	X		X						X	X	X	X	X	X
Others (e.g., copper, lead, zinc,)	X	X					X	X	X	X	X	X		X
Other														
Pathogens	X	X			X		X	X						
Pesticides and herbicides	X	X					X	X	X	X	X	X	X	X
Dioxins/furans and PCBs	X	X					X	X	X	X	X	X	X	X
Polycyclic aromatic hydrocarbons	X	X					X	X	X	X	X	X	X	X
Emerging pollutants (EDCs/PPCPs)	X	X					X	X	X	X	X	X	X	X
Applicable Basin Plan	N, S, Ext	D, N, S, Ext	D, N, S, Ext	D, N, S, Ext	D, N, S, Ext		D, N, S, Ext	D, N, S, Ext	D, N, S, Ext		D, N, S, Ext	D	D, N, S, Ext	D, N, S, Ext

Notes:

D = Delta.
EDC = endocrine-disrupting compound.
Ext = export area.
N = north.
PCB = polychlorinated biphenyl.
PPCP = pharmaceutical and personal care product.
S = south.

<u>Applicable Basin Plans</u>
Delta: Central Valley and San Francisco Bay Water Boards
Export Area: Central Valley, San Francisco Bay, Central Coast, Santa Ana, and Los Angeles Water Boards
North: Central Valley Water Board
South: Central Valley Water Board

1 **Table 8-6. Locations Selected to Represent Existing Water Quality in the Delta**

Location	Data Sources	Justification for Selecting Location
North of Delta Locations		
Sacramento River at Keswick	DWR	Characterizes water quality in the area north of the Delta
Feather River at Oroville	DWR	Characterizes water quality in the area north of the Delta
American River at the E.A. Fairbairn Water Treatment Plant	DWR	Characterizes water quality in the area north of the Delta
Sacramento River at Verona	DWR	Characterizes water quality in the area north of the Delta
Delta Source Water Locations		
Sacramento River at Hood	BDAT, CDEC, MWQI	Characterizes water quality at the northern boundary of the Delta
San Joaquin River near Vernalis	BDAT, CDEC, MWQI	Characterizes water quality at the southern boundary of the Delta
Mokelumne River (South Fork) at Staten Island	BDAT, WDL	Characterizes EC from a major eastern Delta boundary river
Suisun Bay at Bulls Head Point near Martinez	BDAT	Characterizes water quality at the western export area of the Delta; represents saltwater intrusion into the Delta
Delta Interior		
San Joaquin River at Buckley Cove	BDAT	Represents effects of Stockton Deep Water Ship Channel in the eastern Delta near the city of Stockton
Franks Tract at Russo's Landing	BDAT	Characterizes water quality in a reclaimed area in the central portion of the Delta
Old River at Rancho del Rio	BDAT	Characterizes water quality in the central portion of the Delta
Major Outflows		
Sacramento River above Point Sacramento	BDAT, SFEI	Characterizes Sacramento River water quality prior to its confluence with the San Joaquin River; essentially the same location as the SFEI's BG20 station
San Joaquin River at Antioch Ship Channel	BDAT, SFEI	Characterizes San Joaquin River water quality prior to its confluence with the Sacramento River; essentially the same location as the SFEI's BG30 station
Sacramento River at Mallard Island	DWR, MWQI	Characterizes water quality at the western boundary of the Delta; essentially the same location as Sacramento River at Chipps Island
Major Diversions		
North Bay Aqueduct at Barker Slough Pumping Plant	CDEC, MWQI	Major municipal water supply intake in northwestern portion of the Delta
Contra Costa Pumping Plant No. 1	MWQI	Major municipal water supply intake in western portion of the Delta
Harvey O. Banks Pumping Plant	CDEC, MWQI	Major water supply intake; pumps SWP water into the California Aqueduct
C. W. "Bill" Jones Pumping Plant	BDAT, CDEC, MWQI	Major water supply intake; pumps CVP water into the Delta-Mendota Canal
South-of-Delta Locations		
California Aqueduct at Check 13	DWR	Characterizes water quality in the area south of the Delta
California Aqueduct at Check 29	DWR	Characterizes water quality in the area south of the Delta

Notes: BDAT = Bay Delta and Tributaries Project; CDEC = California Data Exchange Center; DWR = California Department of Water Resources; EC = electrical conductivity; MWQI = Municipal Water Quality Investigations; SFEI = San Francisco Estuary Institute; WDL = Water Data Library; WTP = water treatment plant.

2

8.1.2.3 Delta Source Waters

Water quality in the Delta at any given location and time is primarily the result of the sources of water to that location (i.e., the percentage of the water at the site comprising water from the Sacramento River, the San Joaquin River, eastside tributaries, Bay water, in-Delta runoff, and agricultural return flows). Consequently, it is important to characterize the quality of the major sources of water entering the Delta to determine how Delta water quality may change, as the source fractions of water to various locations change with implementation of alternative activities. For the purpose of this section, the water quality of the major Delta source waters will be represented by the following locations.

- Sacramento River at Hood.
- San Joaquin River at Vernalis.
- Mokelumne River at Staten Island.
- Bay water intrusion to Suisun Bay at Martinez.

Figure 8-7 shows the selected locations. It should be noted that the selected Sacramento, San Joaquin, and Mokelumne Rivers monitoring stations are within the statutory Delta and can be affected by tidal action, depending on the stream flow rates. Additionally, the Mokelumne River is directly affected by the flow of Sacramento River water when the Delta Cross Channel is open. However, these locations generally represent the water quality occurring at these perimeter locations in the Delta.

Interior Delta and Outflow Locations

In addition to characterizing the quality of the major source water inputs to the Delta, a number of interior Delta locations were identified for characterizing existing interior Delta water quality. The locations chosen for this purpose were selected based on the following criteria.

- Availability of water quality data (locations used by the various water quality monitoring programs).
- Geographic location in the Delta, in an effort to have one or more stations in the northern, central, eastern, western, and southern portions of the Delta.
- Locations of the primary water supply intakes.
- Bay-Delta WQCP EC compliance locations.
- Other related considerations (e.g., locations of output nodes for Delta Simulation Model 2 [DSM2], reasonable number of locations to support the water quality impact assessments).

Based on the selection criteria listed above, 10 interior and outflow Delta locations were chosen (Figure 8-7) to characterize existing water quality in the Delta and to support the water quality impact assessments.

South of the Delta

The system south of the Delta is influenced primarily by the numerous dams and reservoirs and hundreds of miles of canal that constitute the SWP and CVP (described previously). The SWP and CVP serve as a major source of municipal water supply for Central Coast, San Joaquin Valley, and southern California water contractors and also as one of the major sources of agricultural water supply for the San Joaquin Valley. For the purpose of this assessment, the water quality of the area south of the Delta is represented by two locations along the California Aqueduct.

- California Aqueduct at Check 13.
- California Aqueduct at Check 29.

Figure 8-7 shows the selected locations for the area south of the Delta.

The San Luis Reservoir is a major storage reservoir 50 miles south of the Delta that is used for various control purposes within the system (e.g., storing water from the San Joaquin River and Sacramento River to re-release into the aqueducts). Hence, the water quality downstream of this reservoir is of great importance in characterizing the water quality in the service area. Water exiting the San Luis Reservoir passes through the O'Neill Forebay, which also is fed by water from the California Aqueduct and the Delta-Mendota Canal. The water quality monitoring location at the exit point of the O'Neill Forebay is called the California Aqueduct at Check 13.

South of O'Neill Forebay, there are inflows to the aqueduct, including storm water and flood flows at crossings of several streams and groundwater inflows, prior to water being pumped over the Tehachapi Mountains and into watersheds of water supply reservoirs in the Los Angeles region and areas to the south. DWR accepts the introduction of local groundwater into the aqueduct ("Pump-In" Projects) in accordance with California Water Code provisions that state that nonproject water may be conveyed, wheeled, or transferred in the SWP provided that water quality is protected.

8.1.3 Existing Surface Water Quality

In the following subsections, each constituent of concern (or category of similar constituents) is reviewed in detail to characterize the general patterns of concentrations that exist in the study area at present. The review process followed the steps outlined below.

- Literature review—A wide range of scientific articles, agency reports, and site-specific studies was reviewed to collect the following information:
    - The various structural and nonstructural features and operations in the study area that affect water quality.
    - The importance and relevance of each of the constituents of concern in the study area.
    - The interaction of various constituents and the combined effect on water quality.
    - The historical and current patterns in concentrations of the constituents at selected locations.
    - The variation in concentrations in wet and dry years.
    - Applicable standards and regulatory criteria, and known impairments.
- Some of the key documents reviewed include:
    - Basin Plan for the Sacramento and San Joaquin River basins.
    - Bay-Delta WQCP.
    - CALFED Bay-Delta Program 2000 Water Quality Program Plan.
    - CALFED 2008 State of Bay-Delta Science.

Water quality data for the identified constituents were collected from various monitoring programs and databases. Data were downloaded for selected locations (described in previous section) for each constituent for the period between 1990 and 2009 and stored in a database. In the discussions below, various periods of record are discussed for different constituents and different purposes. The time period of data used to characterize present conditions varied by constituent according to what was available in the database, but in general, data from 2001–2006 are presented as a representative time period that contained both wet and dry years and for which data were available for the entirety of all water years. It must be noted that the characterization provided below is meant to provide a general understanding of water quality conditions and historical monitoring data in the study area. The discussion below is not meant to explicitly define the Existing Conditions for CEQA purposes. The CEQA baseline, *Existing Conditions*, is defined in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and for the purposes of quantitative water quality assessments (as described in Section 8.3.3, *Effects and Mitigation Approaches*, and Section 8.3.4, *Effects and Mitigation Approaches—Alternatives 4A, 2D, and 5A*) is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented below. For more information on the comparisons made to the Existing Conditions modeling run for assessment purposes, see Section 8.3.2.2, *Comparisons*. For these reasons, the time period 2001–2006 was generally considered sufficient for characterization purposes because inclusion of more recent data that have been made available since the start of the environmental review process would not alter the nature of the characterization or the assessment in any substantial way. For instances in which it would be expected that water quality conditions would have changed since this time period, for example, if major sources of a constituent of concern to the Delta were created or eliminated, more recent data was examined and characterized. Appendix 8B, *Summary of Data Availability Used in Environmental Setting*, summarizes the data availability for each of the constituents of concern and locations where substantial information exists for characterizing the Existing Conditions. Depending on the availability of data, the information was presented in various forms.

- Spatial distribution—data presented in a map for individual constituents identifying the location of the sampling station; the date range; and the maximum, minimum, average, and median values.
- Seasonal patterns—plots showing the change in concentrations over time.
- Tabular—tables showing concentrations of constituents where data are discrete or discontinuous.

8.1.3.1 Ammonia

Background and Importance in Study Area

Ammonia, a form of nitrogen, exists primarily in two forms: un-ionized ammonia (NH_3) and an ionized form—ammonium (NH_4^+). In general terms, ammonia and ammonia-N refer to total ammonia (i.e., un-ionized ammonia plus ammonium) in this chapter. The relative levels of un-ionized ammonia and ammonium in a water body depend primarily on pH, and to a lesser extent on temperature and salinity (U.S. Environmental Protection Agency 2009a). Un-ionized ammonia is a gas that is toxic to animals, while ammonium is a solid dissolved in water and an important nutrient for plants and algae. Both ammonium and ammonia are present in effluent from WWTPs that employ only secondary treatment methods, in some types of agricultural runoff (e.g., fertilizers, animal wastes), fish and other wildlife wastes, urban runoff, and atmospheric depositions (Ballard et al. 2009:2). Concern about total ammonia effects in the Delta have led to focused efforts to define and assess the issue (e.g., March 2009 CALFED Science Program Workshop, August 2009 Ammonia Summit). The Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge into the Sacramento River at Freeport is a large point source of ammonia in the Delta. The SRWTP's output has increased with human population growth, and it has contributed to an increase in ammonium concentrations in the Delta downstream of the discharge (Ballard et al. 2009:3). The primary source of total ammonia-N at Hood location is the SRWTP (Central Valley Regional Water Quality Control Board 2010a). The discharge from the SRWTP accounts for 90% of the ammonium load in the Sacramento River at Hood (Jassby 2008).

In the aquatic environment ammonia-N may rapidly cycle among the water, organisms, and sediments. The presence of high concentrations of ammonia-N usually is associated with reducing conditions and/or proximity to locally high concentrations of ammonia-N discharge such as WWTP discharges. Ammonia-N is rapidly oxidized in the flowing river environment to nitrate-N (NO_3^-). More than three quarters of the ammonia present in the Sacramento River downstream of Freeport is converted to nitrate by the time the water reaches Chipps Island (Central Valley Regional Water Quality Control Board 2010a Update memo:4).

Concerns regarding ammonia in the Delta include potential toxicity to fish and other organisms, shifts in algal community structure (e.g., dominant species), and inhibition of nitrate uptake by diatoms. Ammonia can be toxic to aquatic organisms at very low concentrations. The results of a 2008 pilot study to assess the potential acute toxicity of ammonia in treated wastewater effluent from the SRWTP to larval delta smelt suggest that ammonia concentrations present in the Sacramento River below the SRWTP were not acutely toxic to 55-day-old delta smelt. In general, un-ionized ammonia concentrations in the Delta appear to be too low to cause acute mortality of even the most sensitive species. It is unclear whether lower concentrations of ammonia may have chronic effects on species survival, growth, or reproduction (Ballard et al. 2009:7).

There may be a potential for toxic ammonia concentrations in very productive areas in the southern Delta, or smaller productive sloughs or shallow areas throughout the Delta, when high concentrations of un-ionized ammonia coincide with warm temperatures and elevated pH (phytoplankton productivity increases pH, which influences how much un-ionized ammonia is present). In addition, the potential for combined effects of un-ionized ammonia with other toxicants and stressors, and differences in fish sensitivity depending on health status, age, and physiological state, add uncertainty to data analyses (Ballard et al. 2009:7).

Human-induced excesses in nitrogen concentrations, which includes ammonia, can cause eutrophication, or increased biological production. Eutrophic conditions result in enhanced death and decay of biomass and create an oxygen demand in sediments that lowers DO concentrations in the water column (Wetzel 2001). Eutrophic conditions also can affect turbidity and, therefore, the light regime, which can cause changes in the balance of benthic and planktonic productivity. Increases in algal and macrophyte growth can add to the concentrations of dissolved organic carbon (DOC) and TOC in water. Organic carbon in source waters is a constituent of drinking water concern because of DBP formation during water treatment. See the organic carbon section for more on water quality concerns associated with organic carbon and DBPs. Additionally, NH_3 can form nitrogenous DBPs when combined with chlorine.

Nutrient concentrations currently in the Delta are high enough that they are probably not a true limiting factor for overall algal growth, and therefore increases in ammonia generally will not lead to an increase in algal growth (Jassby et al. 2002:1). However, it is unclear whether nutrient levels are adversely affecting algal composition and thus primary productivity. For example, recent work has suggested that elevated cyanobacteria (blue-green algal) concentrations in the Delta interior were associated with nitrogen (including ammonia) and phosphorus concentrations (Lehman et al. 2010). The composition of the phytoplankton community has generally shifted from diatoms toward green algae, cyanobacteria, and miscellaneous flagellate species (Lehman 2000). The changes in phytoplankton composition, and especially the now regularly occurring *Microcystis* blooms, have been implicated as possible factors in the decline of important Delta pelagic fish species, but the connection with ammonia is not clear (Ballard et al. 2009:5).

In addition, Glibert (2010) analyzed more than 30 years of Delta water quality data, concluding that aquatic organism population shifts were associated with changes in the quality and quantity of nutrients discharged from the SRWTP. Subsequently, others have criticized this work by demonstrating that the statistical techniques used were not appropriate and, therefore, that the conclusions were flawed (Cloern et al. 2012:1). Glibert and others agreed that the statistical conclusions of the 2010 review paper should be disregarded (Lancelot et al. 2012). However, a subsequent paper emphasized that changes in nutrient concentrations and nutrient ratios (primarily nitrogen to phosphorus) over time fundamentally affect biogeochemical nutrient dynamics that can lead to conditions conducive to invasions of rooted macrophytes, benthic grazing bivalve mollusks, and blooms of potentially harmful cyanobacteria (Glibert et al. 2011).

Research also has indicated that ammonia, while stimulating diatom growth at very low concentrations, also can inhibit uptake of nitrate in diatoms as concentrations increase above about 4 micromoles per liter (µmol/L) (0.056 mg/L-N) (Dugdale et al. 2007:23). This may be of concern in Suisun Bay, where algal blooms may be prevented when conditions otherwise would be favorable (Wilkerson et al. 2006:1). A recent study showed that, indeed, ammonia concentrations downstream of the SRWTP appeared to inhibit phytoplankton nitrate uptake, and that chlorophyll a and primary productivity were also concurrently reduced for many miles downstream (Parker et al. 2012). The authors attribute the reduced chlorophyll a and primary productivity to the nitrate uptake inhibition, though primary productivity decreases in the reach of the Sacramento River upstream of the SRWTP. Therefore, there is some uncertainty as to the cause of the declines, as the Central Valley Water Board discussed in its findings of the SRWTP NPDES permit issued in 2010: "the SRWTP discharge cannot be cause of pigment decline upstream of the discharge point, and may not be contributing to the decline downstream of the discharge point" (Central Valley Regional Water Quality Control Board 2010b).

Elevated concentrations of ammonium-N and other nutrients also may benefit invasive aquatic plants in the Delta, which are controlled in Delta channels through chemical herbicides and mechanical removal (Ballard et al. 2009:6). However, it is not clear how often ammonia concentrations rise above those concentrations (Engle and Suverkropp 2010).

Research assessing the effects of nitrogen and phosphorus on phytoplankton in the Delta is far from complete due in part to the large number of physical, chemical, and biological interactions occurring in the Delta, e.g., Glibert et al. (2011). In addition to nutrients, Delta phytoplankton can be affected by light conditions, filtration feeders (e.g., *Corbula amurensis*, *Corbicula fluminea*), and microbial processing of organic carbon, to name a few factors (Sacramento Regional County Sanitation District 2009). Manipulation of all these factors to determine their relative contribution to Delta phytoplankton quantity/quality is a significant task that likely will require a broad array of experiments (both laboratory and field) and modeling studies to tease apart causal relationships.

The beneficial uses (Table 8-1) that could be affected most by ammonia concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) or activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing). Drinking water supplies (municipal and domestic supply) and recreational activities (water contact recreation, noncontact water recreation) are indirectly affected by nuisance eutrophication effects of ammonia.

As mentioned above, the SRWTP discharge to the Sacramento River at Freeport is a large point source of ammonia in the Delta. In 2010, the Central Valley Water Board issued an updated NPDES permit for the SRWTP requiring nitrification (i.e., conversion of ammonia to nitrate) and partial denitrification (i.e., removal of nitrate). In its findings, the permit states: "However, as described above, the ammonia discharged by the Discharger is impacting beneficial uses of the Sacramento River, Delta and the Suisun Bay. Therefore, Best Practical Treatment and Control (BPTC) technologies in the form of nitrification and denitrification is required to assure that a pollution or nuisance will not occur and the highest water quality consistent with maximum benefit to the people of the State will be maintained" (Central Valley Regional Water Quality Control Board 2010b). The term BPTC appears in the state antidegradation policy, however BPTC is not defined specifically. BPTC is generally recognized to refer to best available and cost-effective methods that meet performance requirements, such as federal CWA requirements in the case of wastewater treatment plants, and maintain water quality standards. In the discussion leading up to this statement, many concerns regarding ammonia in the discharge are discussed, including potential toxicity concerns, inhibition of diatom primary production, algal community shifts, effects on DO, and nitrosamine formation during disinfection. Subsequently, the permit was appealed to the State Water Board, and the State Water Board upheld requirements related to ammonia removal (State Water Resources Control Board 2012). Further lawsuits were also settled, and therefore the SRWTP will begin ammonia removal in 2021.

Existing Conditions in the Study Area

Most examined locations in the Delta have had low concentrations of ammonia-N in recent years (water years 2001–2006), with mean values typically ranging from 0.03 to 0.11 mg/L (Figure 8-8). The two exceptions are the Sacramento River at Hood and the San Joaquin River at Buckley Cove. The Hood station had a mean value of 0.27 mg/L, a median value of 0.23 mg/L, and a maximum value of 0.84 mg/L. The source of the majority of the ammonia-N at Hood is the SRWTP. The Buckley Cove station had instances of elevated ammonia prior to 2007, due to ammonia-N discharged from the City of Stockton Regional Wastewater Control Facility (RWCF). However, the City of Stockton has since installed a nitrifying biotower system that converts nearly all ammonia in the wastewater to nitrate in the final effluent that is discharged to the San Joaquin River. Therefore, data summarized for this monitoring location in Figure 8-8 is from water years 2008–2012, to reflect current conditions.

Mean values for the north-of-Delta area ranged from 0.01 mg/L at the Feather River at Oroville to 0.07 mg/L at the Sacramento River at Keswick (Table 8-7). South-of-Delta mean values ranged from 0.02 to 0.03 mg/L.

Table 8-7. Ammonia Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Ammonia (mg/L as N)				
Location	Samples	Min	Max	Mean	Median
Sacramento River at Keswick	25	0.03	0.24	0.07	0.03
Sacramento River at Verona	9	0.01	0.10	0.04	0.03
Feather River at Oroville	8	0.01	0.03	0.01	0.01
American River at WTP	14	0.01	0.06	0.02	0.02
California Aqueduct at Check 13	26	0.01	0.12	0.03	0.02
California Aqueduct at Check 29	20	0.01	0.04	0.02	0.01

Source: California Department of Water Resources 2009b.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that ammonia-N concentrations at the examined stations generally fluctuate on an annual basis (Figures 8-9a, 8-9b, and 8-10). Higher values have tended to occur during the months of November through March.

Regulatory criteria with respect to ammonia are as follows. Regarding narrative objectives, as stated in the San Francisco Bay Water Board Basin Plan and Central Valley Water Board Basin Plan, ammonia might be considered a biostimulatory substance because it is the preferred form of nitrogen for plant nutrient uptake, and a toxic compound under certain circumstances (e.g., high un-ionized ammonia concentrations). There are no numerical water quality criteria for the CTR or the Central Valley Water Board Basin Plan, and there is no California drinking water MCL associated with ammonia. The San Francisco Bay Water Board Basin Plan water quality objective of 0.025 mg/L ammonia-N 4-day average for fresh water refers to un-ionized ammonia, which is a function of ionized ammonia, pH, temperature, and salinity. Available data are inadequate to assess whether the sites examined herein exceeded this standard. Because the Central Valley Water Board Basin Plan and CTR lack objectives/criteria for ammonia, the Regional Water Board regulates ammonia through its narrative toxicity objective. Water Board staff rely on the USEPA National Recommended Water Quality Criteria for ammonia (U.S. Environmental Protection Agency 1999a, 2009a) to numerically interpret the narrative standard with regard to ammonia. The USEPA has established criteria for ammonia-N with respect to the toxicity of un-ionized ammonia-N, which is dependent on water temperature and pH (U.S. Environmental Protection Agency 1999a, 2009a). The 2009 document represents draft criteria. A final relevant threshold includes a recommended goal for sensitive crops of 1.5 mg/L-N (Ayers and Westcot 1994).

8.1.3.2 Boron

Background and Importance in Study Area

Boron is a naturally occurring compound found in sediments and sedimentary rocks in the form of borates (e.g., boron oxide, boric acid, borax). Natural weathering of rocks is thought to be the primary source of boron compounds in water and soil (Agency for Toxic Substances and Disease Registry 2007). The richest deposits in the United States are located in California (sediments and brines). Natural sources include releases to air from oceans, volcanoes, and geothermal steam. Total natural global releases of boron from weathering, volcanoes, and geothermal steam are approximately 360,000 metric tons per year (U.S. Environmental Protection Agency 2008a), while releases from seawater range from 800,000 to 4,000,000 metric tons per year (U.S. Environmental Protection Agency 2008b).

Human uses of boron compounds include production of glass, ceramics, soaps, fire retardants, pesticides, cosmetics, photographic materials, and high-energy fuels (U.S. Environmental Protection Agency 2008a). Anthropogenic releases of boron compounds occur through such pathways as air emissions (power plants, chemical plants, manufacturing facilities), soils (fertilizers, herbicide, and industrial wastes), and water (industrial wastewaters, municipal sewage) (Agency for Toxic Substances and Disease Registry 2007). Approximately 180,000 to 650,000 metric tons of boron are released annually into the atmosphere from the industries that use boron and boron-containing products (U.S. Environmental Protection Agency 2008b).

Even though it is found naturally in many fruits and vegetables, boron does not accumulate in human tissues (Waggot 1969; Butterwick et al. 1989). While boron may serve as a trace mineral nutrient for humans, it has potential detrimental health effects such as nausea, vomiting, swallowing difficulties, diarrhea, and rashes due to acute overdoses (U.S. Environmental Protection Agency 2008b). Related effects have occurred in animals. Aquatic plants and animals accumulate boron, but residues do not increase through the food chain (U.S. Environmental Protection Agency 2008a).

USEPA recently evaluated boron and its potential for contamination of drinking water supplies (73 Federal Register [FR] 44251–44261) and made a determination not to regulate boron with a National Primary Drinking Water Regulation. Because boron is not likely to occur at concentrations of concern when considering both surface and groundwater systems, USEPA believes that a National Primary Drinking Water Regulation does not present a meaningful opportunity for health risk reduction.

Agricultural supply uses, specifically crop irrigation, are the most sensitive receptor to boron because of issues related to boron deficiency (Nable et al. 1997) and boron toxicity (Chauhan and Powar 1978; Nable et al. 1997) in crops. Ayers and Westcot (1994) provide a discussion of boron toxicity to plants. Very sensitive plants, which include lemons and blackberries, may show signs of toxicity at concentrations less than 500 micrograms per liter (µg/L) but are not widely grown in the Delta and areas upstream (refer to Chapter 14, *Agricultural Resources*, Table 14-2). Sensitive crops begin to show signs of toxicity between 500 and 750 µg/L and include a variety of fruit and nut trees that are commonly grown in the Delta.

In a study of groundwater from the Sacramento Valley aquifer, boron was detected in all 31 samples, in concentrations ranging from 12 µg/L to 1,100 µg/L (Dawson 2001). The median concentration was 42 µg/L. Two of the 31 samples had concentrations in excess of the then-current Health Advisory Level of 600 µg/L.

Assessment of how human atmospheric emission sources of boron in the Delta directly affect the Delta would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area. Human activities related to boron land and water emissions may be more easily quantified. Land applications of boron in the Delta may include fertilizer, herbicide, and industrial waste; water sources may include industrial wastewaters, municipal sewage, and agricultural return drains.

Approximately 85% of the boron load to the Delta originates from the western side of the lower San Joaquin River, represented by the Grasslands and Northwest Side Subareas. Agricultural drainage, discharge from managed wetlands, and groundwater accretions are the principal sources of boron loading to the river. Additionally, large-scale, out-of-basin water transfers have reduced the assimilative capacity of the river, thereby exacerbating the water quality issues associated with boron.

The source analysis contained in the Central Valley Water Board's TMDL describes the magnitude and location of the sources of boron loading to the lower San Joaquin River. The watershed is divided into seven component subareas to elucidate differences in boron loading between different geographic areas (Figure 8-11).

Contributions of boron to the Delta also originate from other sources, including the Sacramento River, the eastside tributaries, Delta agricultural return drains, and San Francisco Bay. The next section describes how these sources, in addition to the San Joaquin River, contribute to boron concentrations in the Delta.

Existing Conditions in the Study Area

Most examined locations in the Delta have had low concentrations of boron in recent years (water years 2001–2006), with mean values ranging from 0.1 to 0.5 mg/L (Figure 8-12). The Sacramento River at Mallard Island location had a mean value of 0.5 mg/L. Maximum boron values were in the 0.1 to 1.5 mg/L range, with higher values at the San Joaquin River near Vernalis (0.8 mg/L) and the Sacramento River at Mallard Island (1.5 mg/L).

Minimal data were available for the north-of-Delta area, while the mean value for the south-of-Delta stations was 0.2 mg/L (Table 8-8).

Table 8-8. Boron Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Boron (dissolved, mg/L)				
Location	Samples[a]	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	1	–	–	0.1	–
Sacramento River at Verona	NA	–	–	–	–
Feather River at Oroville	NA	–	–	–	–
American River at WTP	NA	–	–	–	–
California Aqueduct at Check 13	64	0.1	0.4	0.2	0.2
California Aqueduct at Check 29	74	0.1	0.3	0.2	0.2

Source: California Department of Water Resources 2009b.

Notes: mg/L = milligrams per liter; NA = not available; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that boron concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-13 and Figure 8-14). Higher values have tended to occur during the months of November through March.

Regulatory criteria with respect to boron are as follows. Because boron is not a priority pollutant, there are no criteria established for boron in the National Toxics Rule (NTR) or CTR. The Bay-Delta

WQCP also does not contain objectives for boron, and there are no California drinking water MCLs. The lower San Joaquin River is listed on the Section 303(d) list as impaired for boron. The impairment extends from downstream of the Mendota Pool to the Airport Way Bridge near Vernalis. As an outcome of the Section 303(d) listing for the lower San Joaquin River and associated TMDL development process, the Central Valley Basin Plan contains a monthly average boron objective for the lower San Joaquin River to Vernalis of 800 μg/L for the irrigation season (March 15 through September 15), and 1,000 μg/L for the non-irrigation season (Central Valley Regional Water Quality Control Board 2009a). Additionally, the San Francisco Bay Basin Plan contains agricultural objectives, with a lower value of 500 μg/L for irrigation and a value of 5,000 μg/L for stock watering.

8.1.3.3 Bromide

Background and Importance in the Study Area

Bromide is an inorganic anion that is generally present at low concentrations in freshwater bodies. Bromide has the potential to most directly affect municipal and domestic supply, agricultural supply, and industrial service supply beneficial uses (Table 8-1). Typical drinking water source concentrations of bromide in the United States average 0.062 mg/L (Amy et al. 1998); typical seawater concentrations of bromide are 65–67 mg/L (Morris and Riley 1966: 699; Hem 1985).

In addition to its contribution to salinity, bromide is of concern in water as a precursor to the formation of bromate, bromoform and other brominated THMs, and HAAs, which are potentially harmful DBPs in municipal water supplies (CALFED Bay-Delta Program 2003). These compounds have been shown to cause carcinogenic, negative developmental, and negative reproductive effects in laboratory animals (U.S. Environmental Protection Agency 2010). DBP formation is increased when the source water contains both dissolved organic compounds and halides (CALFED Bay-Delta Program 2007a). Bromate forms when water that contains bromide is disinfected with ozone, a technique employed by many drinking water treatment plants as an alternative to chlorination to reduce DBP formation (in compliance with THM Rule, DBP Stage 1 and Stage 2 Rules).

The primary source of bromide in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000). As discussed in the salinity subsection with respect to salinity, bromide in the Delta is the result of a complex interplay between hydrology (dilution), water operations, bromide sources, and hydrodynamics. Because there are several major water diversions in the Delta for municipal water supplies, bromide in the source water is of concern because of the potential for DBP formation. Bromide concentrations also can be generally higher in the lower San Joaquin River and Delta island agricultural drainage as a result of agricultural irrigation practices and evaporative concentration that occurs in water diverted from the Delta for irrigated agriculture. Recirculation, or the process of agricultural drainage entering the San Joaquin River and its subsequent and repetitive diversion for agricultural practices, has also contributed to elevated bromide concentrations in the San Joaquin River.

Median concentrations at the southern Delta export pumps are about 16 times higher than in the Sacramento River at Hood, and other tributaries upstream of any seawater influence (CALFED Bay-Delta Program 2007b). Based on historical data and current conditions, bromide concentration in water diverted from the southern Delta can be estimated from EC or chloride data, with chloride being the most reliable indicator (Public Policy Institute of California 2008).

Existing Conditions in the Study Area

Locations in the northern Delta have had low concentrations of bromide in water years 2001–2006 with mean values of 0.02 and 0.04 mg/L at the Sacramento River at Hood and Barker Slough pump locations, respectively (Figure 8-15). Higher mean concentrations typically are seen in the southern Delta, with values of 0.18 mg/L at the Banks pumps, 0.27 mg/L at the San Joaquin River near Vernalis, and 0.28 mg/L at CCWD pumping plant #1. The highest mean value examined was 5.18 mg/L at the Sacramento River at Mallard Island.

Time series data indicate that bromide concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-16) but depend on location. For example, higher values have tended to occur during the months of March through May at the Barker Slough pumps, while higher values occurred during the October to early January period at CCWD pumping plant #1. Bromide data for the north and south-of-Delta stations were sparse; values were available for the American River at WTP and were all reported as 0.01 mg/L.

There are presently no regulatory water quality objectives for bromide in the Delta. Bromide is not a priority pollutant; thus, the CTR has no criteria for bromide. There are no state or federal regulatory water quality objectives/criteria for bromide, or any USEPA-recommended criteria. The state drinking water primary MCL for bromate is 0.01 mg/L. To reduce the potential for DBP formation in municipal water supplies, the CALFED Drinking Water Quality Program has the goal of achieving either a bromide concentration of 0.05 mg/L at the southern and central Delta water export locations, along with an average TOC concentration of 3 mg/L (CALFED Bay-Delta Program 2000), or an "Equivalent Level of Public Health protection" for municipal water supply purveyors. Specifically, the goal of the CALFED Drinking Water Program is to:

> achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 μg/L [0.05 mg/L] bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies. (CALFED Bay-Delta Program 2000)

In general, bromide concentrations are frequently above 0.05 mg/L at Delta locations influential to the water quality of surface water supply purveyors.

The basis of the bromide goal is described in the Final Draft of the CALFED Water Quality Program Stage 1 Final Assessment as follows:

> In 1998, a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies (CUWA), produced a report titled "Bay-Delta Water Quality Evaluation, Draft Final Report". CUWA had charged the panel with developing potential regulatory scenarios, defining appropriate treatment process criteria, and estimating the Delta source water quality required to achieve compliance under the anticipated regulatory scenarios…The panel identified two regulatory scenarios for their evaluation, a near-term scenario consisting of the then current treatment rules governing pathogen inactivation and disinfection and a long-term scenario which included the anticipated more stringent versions of these rules then under development. The long term scenario, referred to in this report as the CALFED ELPH targets, were regulatory levels of 40 μg/L total trihalomethanes (TTHMs), 30 μg/L haloacetic acids (HAA5s), and 5 μg/L bromate (as running annual averages) as well as an additional 1 to 2-log inactivation of *Giardia* and 1-log inactivation of *Cryptosporidium*. The panel focused on inactivation requirements and the DBP precursors TOC and bromide as the constituents in Delta water that would be most likely to drive treatment technology decisions. Their basic finding was that, under the more stringent long-term scenario, it would be necessary to keep Delta water diverted for municipal use to no more than 3 mg/L TOC and 50 μg/L [0.05 mg/L] bromide to give users flexibility in their choice of treatment method (enhanced

> coagulation or ozone disinfection)…For the less stringent near-term regulatory scenario, TOC from 4 to 7 mg/L and bromide from 100 to 300 µg/L [0.1 to 0.3 mg/L] was determined to be acceptable. (CALFED Water Quality Program 2007).

The more stringent regulations envisioned at the time the 0.05 mg/L bromide goal for source waters was recommended have not yet been realized. The only changes implemented compared to the less stringent near-term regulatory scenario evaluated are that the running annual average bromate MCL has been changed to a locational running average that must be met at all points in the treatment and distribution system, and additional *Cryptosporidium* inactivation is required for higher risk systems, dependent on monitoring outcomes. In general, these do not affect the levels of bromide in source water that would require drinking water treatment or source water modification for compliance with current MCLs.

Although the projected long-term reduction in the bromate MCL has not occurred, it is still possible that it will be reduced in the future. The U.S. EPA maximum contaminant level goal (MCLG) for bromate is 0 mg/L, and the current MCL of 0.01 mg/L is set at the current analytical practical quantitation limit (PQL) for bromate, determined by the U.S. EPA through an analytical feasibility analysis. While the U.S. EPA's most recent Analytical Feasibility Support Document for the Second Six-Year Review of Existing National Primary Drinking Water Regulations (U.S. EPA 2010) did not recommend a lowering of the bromate PQL, and thus MCL, below 0.01 mg/L, recent adoption of new analytical methods could lead to an improved PQL, and thus reduced MCL. This means that in 2016, or the time of the next Six-Year Review of National Primary Drinking Water Regulations, it is possible the bromate MCL will be lowered to the 0.005 mg/L value assumed in the derivation of the 0.05 mg/L CALFED bromide goal.

8.1.3.4 Chloride

Background and Importance in the Study Area

Chloride is an inorganic anion generally found at low concentrations in freshwater bodies; however, chloride is the dominant anion in seawater at about 19,000 mg/L (Hem 1985). Chloride commonly occurs in nature as salts of sodium, potassium, and calcium. Tidal seawater intrusion is the primary source of chloride in the Delta. Delta tidal water containing elevated levels of chloride, which is subsequently diverted for agricultural irrigation uses on Delta islands or exported from the Delta via the Banks and Jones pumping plants to the San Joaquin valley, returns to the Delta as agricultural drainage (CALFED Bay-Delta Program 2007a). Chloride concentrations in these return flows to the Delta can contain additional chloride as a result of evaporative concentration of salts that occurs in water diverted for agricultural irrigation. Chloride is a potential concern for crop yields in agricultural irrigation water, and excess chloride can impart an unpalatable, "salty" taste in drinking water supplies. Taste thresholds for chloride range from 200 to 300 mg/L, depending on the associated cation (World Health Organization 2003).

Existing Conditions in the Study Area

Locations in the northern Delta had low concentrations of chloride in water years 2001–2006, with mean values of 6 and 22 mg/L at the Sacramento River at Hood and Barker Slough pump locations, respectively (Figure 8-17). Higher mean concentrations typically are seen in the southern Delta, with values ranging from 59 mg/L at the Banks pumps to 90 mg/L at both CCWD pumping plant #1 and Franks Tract. Chloride mean concentrations increased at the mouths of the Sacramento River and San Joaquin River, with the highest value of 6,380 mg/L at Suisun Bay at Bulls Head near Martinez.

Chloride mean concentrations in the north-of-Delta locations were very low (water years 2001–2006), ranging from 1 to 5 mg/L (Table 8-9). South-of-Delta locations had mean values of 69 mg/L, which were higher than that reported at the Banks headworks (59 mg/L, Figure 8-17).

Table 8-9. Chloride Concentrations at Selected North of Delta and South-of-Delta Stations, Water Years 2001–2006[a]

	Chloride (dissolved, mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	46	1	6	2	2
Sacramento River at Verona	21	2	15	5	4
Feather River at Oroville	29	1	3	1	1
American River at WTP	69	1	3	2	2
California Aqueduct at Check 13	69	23	138	69	64
California Aqueduct at Check 29	81	16	127	69	66

Source: California Department of Water Resources 2009b.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data for chloride displayed annual fluctuations (Figures 8-18a, 8-18b, and 8-19), with peaks typically occurring in fall/winter.

The Bay-Delta WQCP contains chloride objectives for municipal and industrial water supply beneficial uses protection, including a maximum mean daily concentration of 250 mg/L year-round at the five major municipal water supply diversion locations—Contra Costa Canal at pumping plant #1, West Canal at mouth of Clifton Court Forebay, Jones pumping plant, Barker Slough at North Bay Aqueduct, and Cache Slough at the City of Vallejo intake (abandoned). Table 8-9a summarizes the record of compliance with the Delta chloride objectives that are specified in the Bay-Delta WQCP. The 250 mg/L standard has been exceeded at the CCWD pumping plant #1 on several occasions in 4 of the past 20 years. Additionally, the Bay-Delta WQCP contains a chloride objective for Contra Costa Canal at pumping plant #1 or the San Joaquin River at Antioch Water Works intake that specifies the number of days each calendar year that the maximum mean daily chloride concentration must be less than 150 mg/L (must be provided in intervals of not less than 2 weeks' duration). The days per year depend on water-year type, ranging from 155 days for critical water-year types to 240 days in wet water-year types. The industrial uses for which this objective was established (cardboard manufacturing in Antioch) no longer exist; however, the objective has been retained for general municipal use protection (CALFED Bay-Delta Program 2007a). Delta water supply operations have been able to maintain compliance with the 150 mg/L standard.

Table 8-9a. Summary of Compliance with Delta Chloride Objectives (1995–2014)

	Objective[a, b]		Exceedances of Objective		
Location	Applicable Period (and narrative description)	Days/Year[c]	Years with Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded[d]
Municipal and Industrial Water Supply Objectives					
CCF	Jan 1–Dec 31 md Cl <= 250 mg/L	365	0	0	0
DMC at Tracy PP	Jan 1–Dec 31 md Cl <= 250 mg/L	365	0	0	0
CCC at PP#1	Jan 1–Dec 31 md Cl <= 250 mg/L	365	4	7	2.5
CCC PP#1 or SJR @ Antioch Intake	Jan 1–Dec 31 Chloride (days <150 mg/L Cl varies by water year).	Varies by water year–type	0	0	0

Notes: CCF = Clifton Court Forebay; CCC = Contra Costa Canal; Cl = chloride; DMC= Delta-Mendota Canal; md = mean daily; mg/L = milligrams per liter; PP=Pumping Plant; SJR = San Joaquin River.

[a] This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

[b] Only partial description of objective provided; refer to Bay-Delta Water Quality Control Plan for full text of objective.

[c] Total number of days in year that requirement is applicable.

[d] Median calculated using only years when exceedances occurred.

The secondary MCL for chloride is specified as a range: 250 mg/L (recommended), 500 mg/L (upper), and 600 mg/L (short-term) and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The USEPA's recommended chloride ambient water quality criteria for the protection of freshwater aquatic life are 230 mg/L (chronic 4-day average) and 860 mg/L (acute 1-hour average). The San Francisco Bay Water Board Basin Plan has a 355 mg/L chloride objective for agricultural supply. CCWD has a goal of delivering treated water that has less than 65 mg/L chloride.

One channel in the southern Delta (Tom Payne Slough) and Suisun Marsh is on the state's CWA Section 303(d) list because of elevated chloride (State Water Resources Control Board 2011). Additionally, the lower San Joaquin River is on the 303(d) list as impaired for salt and boron, and a TMDL has been developed with chloride identified as composing about 23% of the total ions contributing to salinity in the lower San Joaquin River at the Vernalis location in the Delta (Central Valley Regional Water Quality Control Board 2002).

8.1.3.5 Dioxins, Furans, and Polychlorinated Biphenyls

Background

Dioxins and dioxin-like compounds are a chemical compounds with similar chemical structures and biotic effects (U.S. Food and Drug Administration 2009). There are several hundred of these compounds, which can be grouped into three families: chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, and certain polychlorinated biphenyls (PCBs). One of the most toxic (and most studied) dioxins is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans are created unintentionally, usually through combustion processes. PCBs are manufactured products but are no longer produced in the United States. Dioxin/furan compounds and PCBs break down very slowly in the environment, indicating that past and present emissions will continue to interact with soils, water, and biota (e.g., Wenning et al. 1999; Gullett et al. 2003; Brown et al. 2006).

The most common health effect in people exposed to large amounts of dioxins is chloracne, possibly followed by skin rashes, skin discoloration, and excessive body hair and possibly mild liver damage (U.S. Food and Drug Administration 2009). A concern is the cancer risk associated with dioxins. High exposures over long periods (animal studies, human workplace studies) have suggested an increased cancer risk as well as possible reproductive and developmental effects. Toxicity levels are very broad between the various dioxin compounds, up to several orders of magnitude. The health effects associated with dioxins depend on a variety of factors, including the level, timing, duration, and frequency of exposure.

The class of PCBs consists of 209 individual congeners, of which 12 have dioxin-like properties. In general, PCBs can cause developmental abnormalities, growth suppression, disruption of the endocrine system, impairment of immune function, and cancer (State Water Resources Control Board 2007). PCBs can bioaccumulate and reach higher concentrations in higher levels of aquatic food chains; predatory fish, birds, and mammals (including humans that consume fish) at the top of the foodweb are particularly vulnerable to the effects of PCB contamination. Consequently, the beneficial uses (Table 8-1) most directly affected by dioxin/furan compounds and PCBs are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened and endangered species if the community population level were to be reduced by exposure through the aquatic environment; harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing); and drinking water supplies (municipal and domestic supply).

Dioxins may enter the environment through air, water, and land pathways. Because the majority of dioxin releases are to the atmosphere, some dioxins can be transported very long distances and can be found in most places in the world (National Research Council 2006; U.S. Food and Drug Administration 2009). In water, dioxins tend to settle into sediments where they can move up the food chain. Dioxins can also be deposited on plants and enter the food chain. Animals tend to accumulate dioxins in fatty tissues.

USEPA (2006a) estimated that the primary pathway of dioxin releases to the environment is atmospheric (92.4%), with 5.7% to the land and 1.8% to water. It is important to note that this estimate did not include natural sources of dioxins, which exceed those produced by human activities (Centers for Disease Control 2005). Dioxins are ubiquitous, and all living organisms have had some form of low-level exposure. Natural brush and forest fires produce dioxins, so it is reasonable to assume that organisms have been exposed to dioxins for centuries. For example, 54% of global dioxin emissions were from natural forest fires in 2004, with the remainder coming from anthropogenic sources (Figure 8-20).

PCBs were used commonly in the United States for the production of transformers and capacitors in electrical equipment (Brinkmann and de Kok 1980). Other uses included hydraulic fluids, lubricants, inks, and as a plasticizer (State Water Resources Control Board 2007). While production of transformers and capacitors containing PCBs ended in the United States in 1979, the persistent nature of PCBs in the environment is still a source of concern (Davis et al. 2007).

Importance in the Study Area

Assessment of how human atmospheric emission sources of dioxins, furans, and PCBs in the study area directly affect the Delta would be difficult, given the complexity of area meteorology. Based on the USEPA (2006b) analysis, the major sources likely would be backyard barrel burning of refuse and medical waste/pathological incineration. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area.

Human activities related to land and water emissions may be more easily quantified and, based on the USEPA (2006b) analysis, likely would be dominated by application of municipal wastewater treatment sludge (land), ethylene dichloride/vinyl dichloride production (land, water), chlor-alkali facilities (water), and bleached, chemical wood pulp and paper mills (water).

Existing Conditions in the Study Area

There are two portions of the study area that are on the Section 303(d) listing for impairment with respect to dioxins, furans, and PCBs. The Stockton Deep Water Ship Channel is listed for dioxins/furans for the overall channel, and 3.3 miles of the channel are listed for PCBs. The north Delta has a PCB impairment listing for 15.5 miles of drainage canal near Sacramento.

Hayward et al. (1996) found that sediment concentrations of dioxins and furans near a USEPA Superfund site in the Stockton area (specifically, a wood treatment facility) were highly localized and likely attributable to pentachlorophenol use at the facility.

Contributions of dioxins to the Delta originate from several sources, including the Sacramento River, the San Joaquin River, the eastside tributaries, Delta agricultural return drains, and San Francisco Bay. The section below quantifies how these sources contribute to concentrations in the Delta.

Minimal dioxin and furan data have been collected as part of water quality monitoring programs in the study area. For example, pentachlorophenol and carbofuran have been analyzed at the Banks pumping plant three times a year since 1995 with no detections.

There was a large monitoring effort from 1988 to 1993 to assess PCBs in the Delta. The study examined the seven most common commercial mixtures of PCBs produced prior to the production ban in 1977 identified as PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260 (Bay Delta and Tributaries Project 2009). The stations from this monitoring that coincide with the stations examined in this section are the San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract. Analysis of the monitoring results indicated that no detections of PCBs occurred in any samples from these locations.

Recent monitoring efforts to assess PCBs in the study area are limited to four of the selected locations, including the Banks pumping plant, the Barker Slough pumping plant, the Sacramento River above Point Sacramento, and the San Joaquin River at Antioch Ship Channel. The latter two stations were sampled for forty of the individual PCB congeners (ranging from PCB 008 to PCB 203) on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of 0.01 picograms per liter (pg/L), which are about 10,000,000 times more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants.

Analytes examined in the present effort for the Banks and Barker Slough pumping plants included the PCB mixtures (i.e., PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260). The monitoring program sampled for each of these analytes approximately 16 times during the water years 2001 to 2006 for each location. No detections were found. The very low detection limits of the SFEI monitoring has enabled the detection of many PCBs at the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel locations examined in the current study, which are presented as the sum of all PCB congeners in Table 8-10.

Table 8-10. Sum of All Polychlorinated Biphenyls at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PCBs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	35	70	52	50
Total	6	67	138	99	95
San Joaquin River at Antioch Ship Channel					
Dissolved	5	47	60	53	53
Total	5	70	254	120	98

Source: San Francisco Estuary Institute 2010.

Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.
PCB = polychlorinated biphenyl.

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that PCBs are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for the sum of all PCBs were comparable at the two locations.

Sampling at south-of-Delta locations at California Aqueduct Check 13 and Check 29 for the same constituents also resulted in no detections during the same time period. Sampling at the north-of-Delta locations (approximately 35 to 60 visits per site) resulted in multiple detections at the Sacramento River at Keswick, the Feather River at Oroville, and the Sacramento River at Verona; however, the sampling and analytical protocol for these data were not available, and the validity of the data could not be confirmed.

Regulatory criteria with respect to dioxins, furans, and PCBs are as follows. Dioxin compounds are on the Section 303(d) list for San Francisco Bay (source of contamination unknown) and the Central Valley (source: unknown point source near the Stockton Deep Water Ship Channel). Furan compounds are on the Section 303(d) list for San Francisco Bay (source: atmospheric deposition) and the Central Valley (source: contaminated sediments). PCBs and dioxin compounds are on the Section 303(d) list for San Francisco Bay (sources: unknown nonpoint, unknown).

With regard to Basin Plan narrative objectives, any of the compounds above might be considered toxic at high concentrations. There are no numerical water quality objectives for the San Francisco Bay Water Board or Central Valley Water Board Basin Plans. The California drinking water standard MCL for 2,3,7,8-TCDD is 0.00003 µg/L; the MCL for carbofuran in 18 µg/L. The CTR for 2,3,7,8-TCDD is 0.000013 ng/L for Human Health: Water and Organisms, and 0.000014 ng/L for Human Health: Organisms Only. Data are inadequate to assess whether the sites examined in this SFEI monitoring exceeded this standard.

The CTR criteria for PCBs (sum of six aroclors) is 0.014 µg/L (freshwater chronic), 0.03 µg/L (saltwater chronic), 0.00017 µg/L (Human Health: Water and Organisms), and 0.00017 µg/L (Human Health: Organisms Only). Data examined in this study indicate that these criteria have not been exceeded.

8.1.3.6 Dissolved Oxygen

Background and Importance in the Study Area

DO is a measure of the concentration of oxygen carried in a water body. Water gains oxygen from the atmosphere and from aquatic plant photosynthesis. DO in water is consumed through respiration by aquatic animals, decomposition of plant and animal material (microbial respiration), sediment oxygen demand, and various chemical processes. DO depletion affects primarily aquatic life beneficial uses, which include warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms and spawning, reproduction, and/or early development; estuarine habitat; and rare, threatened, or endangered species (Table 8-1). The most sensitive receptors are cold freshwater habitat and migration of aquatic organisms and spawning, reproduction, and/or early development because of the relatively high DO requirements of coldwater fish, such as Chinook salmon and steelhead. Low DO concentrations in water bodies can have adverse effects on aquatic life, including fish kills, fish egg mortality, and growth rate reductions, and can serve as a barrier to migration of anadromous fish such as Chinook salmon (Central Valley Regional Water Quality Control Board 2005; Schmieder et al. 2008).

Seasonal declines in DO are typical in many estuaries, and DO concentrations are negatively affected by increases in water temperature (Schmieder et al. 2008). Nutrient loading from point and nonpoint sources can result in increased algal growth, thereby causing higher DO levels when blooms are photosynthesizing and lowering DO levels during night time hours and when the blooms die and decompose (Schmieder et al. 2008) Activities that disturb sediments and aquatic plants such as dredging and clearing of aquatic plants from ship channels can cause increased decomposition of organic material, resulting in decreases in DO concentrations (Greenfield et al. 2007; Schmieder et al. 2008). However, removal of aquatic plants, especially invasive surface-covering plant species, may allow light to better penetrate the water column, increasing photosynthesis and thereby increasing DO concentrations (Greenfield et al. 2007). On the other hand, submerged macrophytes tend to cause suspended sediment to settle and increase water clarity (Madsen et al. 2001)

Although localized incidents of depressed DO concentrations may occur in the study area, notable low DO concentrations occur in the Stockton Deep Water Ship Channel, and to a lesser extent in Middle River and Old River. Additionally, low DO conditions occur in areas of the Suisun Marsh channels, particularly in small, isolated, backwater slough areas that receive little exchange of water (San Francisco Bay Regional Water Quality Control Board 2012). The San Joaquin River experiences regular periods of low DO concentrations in the Stockton Deep Water Ship Channel from the city of

Stockton downstream to Disappointment Slough. These conditions often violate the Basin Plan water quality objective for DO in the Stockton Deep Water Ship Channel; they occur most often during the months of June through October, although severe conditions have occurred in the winter months as well (Central Valley Regional Water Quality Control Board 2005; Schmieder et al. 2008). Data also show that the frequency and severity of low DO concentrations are generally worse during dryer water years (Table 8-11) (Central Valley Regional Water Quality Control Board 2005). Jassby and Van Nieuwenhuyse (2005) found that low DO was due to a combination of low flow and high nutrient loads. The 2012 draft *Pulse of the Delta* reports that DO in the lower San Joaquin River has increased since the early 2000s, primarily due to the implementation of algae removal ponds and nitrification treatment by the Stockton RWCF. However, monthly minimum values continue to fall frequently below the statutory limits of 5 mg/L (December 1 to August 31) and 6 mg/L (September 1 to November 30) (Aquatic Science Center 2012:56).

The Stockton Deep Water Ship Channel is a portion of the San Joaquin River that has been dredged by the U.S. Army Corps of Engineers (USACE) to a depth of 35 feet to allow the navigation of cargo vessels between San Francisco Bay and the Port of Stockton. Upstream of the channel, the San Joaquin River is otherwise about 10 feet deep. The entire length of the channel is within the tidal prism and experiences regular flow reversals (Central Valley Regional Water Quality Control Board 2005). Increased water depth increases the time required to aerate the water column and the residence time of water in the channel and promotes stronger thermal stratification during summer months, which lessens the amount of mixing; these conditions negatively affect DO concentrations in the channel (Schmieder et al. 2008).

The occurrence of low DO concentrations also coincides with periods of low-flow conditions, indicating that flow and channel morphology in the San Joaquin River are important factors influencing DO conditions in the Stockton Deep Water Ship Channel. Table 8-11 demonstrates that the frequency of violations of the 5.0 mg/L objective since 1983 is highest, on the average, during the months of June through October (Central Valley Regional Water Quality Control Board 2005; California Department of Water Resources 2009b). Oxygen concentrations less than 5.0 mg/L, however, have occurred during all months of the year. The frequency of violations is worse in dry years (1991 through 1993) and less frequent during wet years (1998) (Central Valley Regional Water Quality Control Board 2005). An analysis of more than 20 years of time series data suggests that the low DO problem is attributable to a combination of river discharge, river phytoplankton, and formerly discharges of elevated ammonia levels from the Stockton RWCF, (which releases approximately 53 million gallons per day (mgd) of effluent), including large seasonal wastewater loading from food canneries (Jassby and Van Nieuwenhuyse 2005).

Table 8-11. Temporal Distribution of Low Dissolved Oxygen Impairment

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983	Excursion rate (%)[a]	NA	NA	NA	NA								
	Minimum (DO)[b]												
1984	Excursion rate (%)[a]				1	7	84	91	62	2			
	Minimum (DO)[b]				*4.4*	*3.9*	*3.0*	*2.8*	*4.0*	*4.7*			
1985	Excursion rate (%)[a]				6		48	78	15				
	Minimum (DO)[b]				*4.4*		*3.3*	*3.5*	*4.2*				
1986	Excursion rate (%)[a]	29				5		21	9				
	Minimum (DO)[b]	*4.4*				*3.1*		*4.5*	*4.8*				
1987	Excursion rate (%)[a]					44	43	3		29		<1	
	Minimum (DO)[b]					*3.5*	*3.6*	*4.6*		*3.9*		*4.9*	
1988	Excursion rate (%)[a]	51	52	52			3		10	62			
	Minimum (DO)[b]	*3.5*	*3.3*	*3.8*			*4.8*		*4.4*	*2.3*			
1989	Excursion rate (%)[a]			65	<1		37	2		38	14		
	Minimum (DO)[b]			*3.7*	*4.9*		*4.1*	*4.8*		*2.4*	*4.2*		
1990	Excursion rate (%)[a]			1	5	3	11	<1	<1				
	Minimum (DO)[b]			*4.8*	*4.6*	*4.7*	*4.5*	*4.8*	*4.9*				
1991	Excursion rate (%)[a]		<1	8	37	34	1	5	14	55	99		
	Minimum (DO)[b]		*4.7*	*4.3*	*4.4*	*4.2*	*4.9*	*4.7*	*4.4*	*1.8*	*0.4*		
1992	Excursion rate (%)[a]		21	100	60	29	43	39	97	100	77	6	
	Minimum (DO)[b]		*3.1*	*2.1*	*1.9*	*3.6*	*3.7*	*3.7*	*2.8*	*0.5*	*1.3*	*4.7*	
1993	Excursion rate (%)[a]			25	8	2	29	54	87	81	23		1
	Minimum (DO)[b]			*3.7*	*4.7*	*4.8*	*3.6*	*3.7*	*2.6*	*2.6*	*1.6*		*4.8*
1994	Excursion rate (%)[a]		2		<1		61	80	63	16	46		
	Minimum (DO)[b]		*4.8*		*4.9*		*4.0*	*3.7*	*3.4*	*4.3*	*3.2*		
1995	Excursion rate (%)[a]							2	61	6			
	Minimum (DO)[b]							*4.8*	*3.0*	*4.6*			
1996	Excursion rate (%)[a]	15	NA				8	63	94	89	15	18	
	Minimum (DO)[b]	*4.1*					*4.8*	*3.4*	*2.0*	*2.5*	*3.7*	*4.3*	
1997	Excursion rate (%)[a]						14	74	88	83	44	2	11
	Minimum (DO)[b]						*3.6*	*3.1*	*3.3*	*2.4*	*2.2*	*4.7*	*4.5*
1998	Excursion rate (%)[a]												
	Minimum (DO)[b]												
1999	Excursion rate (%)[a]					NA	<1	48	20	43	100	93	39
	Minimum (DO)[b]						*4.9*	*3.0*	*3.1*	*1.8*	*1.7*	*3.8*	*3.8*
2000	Excursion rate (%)[a]	4	11				11	61	28	1			12
	Minimum (DO)[b]	*4.7*	*3.9*				*2.9*	*2.9*	*2.7*	*4.8*			*4.7*
2001	Excursion rate (%)[a]	5					69	75	73	61			NA
	Minimum (DO)[b]	*4.7*					*2.5*	*2.3*	*3.0*	*2.9*			
Avg[c]		5	6	14	6	6	27	34	37	36	23	3	4

Source: Central Valley Regional Water Quality Control Board 2005.

Notes: DO = dissolved oxygen.

For each month of the year in the table, the upper number presented is the percentage of hourly DO measurements below 5.0 mg/L recorded that month. If a cell is blank, there were no DO measurements below 5.0 mg/L that month. If a cell contains "NA," no data were recorded at all for that month. The lower italicized number presented for each month is the minimum DO concentration measured that month. The average rate (weighted to account for months with partial data sets) for the 19-year period is shown in the bottom row.

[a] Excursion rate is the number of hourly average DO measurements from the California Department of Water Resources monitoring station below 5.0 mg/L divided by the total number of such measurements recorded that month, shown as a percentage.

[b] The minimum hourly average DO measurement for the month in mg/L.

[c] Average excursion rate is not the simple average of all monthly data—it is weighted to account for months that had only partial data sets.

Existing Conditions in the Study Area

All examined locations in the Delta had mean DO concentrations above 8.4 mg/L in recent years (water years 2001–2006) except the San Joaquin River at Buckley Cove (6.8 mg/L, Figure 8-21). DO minima were below 7.0 mg/L at approximately 40% of examined stations including the Sacramento River at Hood (4.8 mg/L), which was the only value at that location below 6.0 mg/L during that time period, the San Joaquin River at Vernalis (4.3 mg/L), the Sacramento River at Mallard Island (6.5 mg/L), and the San Joaquin River at Buckley Cove (3.3 mg/L), which falls under the Stockton Deep Water Ship Channel water quality criteria. Mean values for the north-of-Delta area ranged from 9.6 mg/L at the American River at WTP to 11.0 mg/L at the Sacramento River at Keswick (Table 8-12). South-of-Delta mean values were lower than north-of-Delta stations examined (8.2 to 8.9 mg/L).

Time series data indicate that DO concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-22 and Figure 8-23). Higher values have tended to occur during the months of November through March, with lower values occurring during June through September. The San Joaquin River at Buckley Cove site has continued to experience low DO concentrations, primarily in the late summer to late fall period.

Table 8-12. Dissolved Oxygen Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Dissolved Oxygen (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	7.3	15.6	11.0	11.1
Sacramento River at Verona	15	5.4	13.0	10.0	10.0
Feather River at Oroville	29	7.4	12.5	10.1	10.2
American River at WTP	120	6.5	13.0	9.6	9.5
California Aqueduct at Check 13	68	5.7	10.9	8.9	9.0
California Aqueduct at Check 29	49	0.0	12.6	8.2	9.5

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

The 2006 Bay-Delta WQCP, Region 2 Basin Plan, and Region 5 Basin Plan all contained DO objectives applicable to water bodies in the affected environment. A DO objective for protection of fish and wildlife beneficial uses exists in the 2006 Bay-Delta WQCP for the San Joaquin River between Turner Cut and Stockton: 6.0 mg/L from September through November (State Water Resources Control Board 2006). The Region 5 Basin Plan has the same objective for the San Joaquin River, and the Region 2 Basin Plan incorporates by reference the DO objectives in the 2006 Bay-Delta WQCP (Central Valley Regional Water Quality Control Board 2009a; San Francisco Bay Regional Water Quality Control Board 2007). The Region 5 Basin Plan contains the following additional numerical DO objectives for the Delta (Central Valley Regional Water Quality Control Board 2009a).

- At least 7.0 mg/L in the Sacramento River below the I Street bridge and west of the Antioch Bridge.
- At least 5.0 mg/L at all other locations and times, unless the water body has been constructed for special purposes and fish are excluded or not important as a beneficial use.

In addition, the Region 5 Basin Plan requires that water bodies outside the legal boundary of the Delta meet certain saturation levels and not be reduced below the following levels at any time.

- Waters designated WARM, 5.0 mg/L.
- Waters designated COLD, 7.0 mg/L.
- Waters designated SPWN, 7.0 mg/L.

The Region 2 Basin Plan also has minimum DO objectives for warm and coldwater habitat of 5.0 mg/L and 7.0 mg/L, respectively (San Francisco Bay Water Board 2007). Lastly, the Region 5 Basin Plan contains a DO objective for the Sacramento River from Keswick Dam to Hamilton City of 9.0 mg/L (or 95% saturation) from June 1 to August 31, and an objective of 8.0 mg/L for the Feather River from Fish Barrier Dam at Oroville to Honcut Creek from September 1 to May 31 (Central Valley Regional Water Quality Control Board 2009a). There are no DO criteria in the CTR (as it is not a priority pollutant), nor is there a California drinking water MCL for DO.

Water bodies in the affected environment listed on the state's CWA Section 303(d) list as impaired because of low DO levels include Middle River, Old River, the Stockton Deep Water Ship Channel and portions of other sloughs and rivers in the southern, eastern, and western Delta (State Water Resources Control Board 2011). A TMDL for the Stockton Deep Water Ship Channel was approved by USEPA on February 27, 2007, and includes a Region 5 Basin Plan Amendment that contains a Control Program to reduce the amount of oxygen-demanding substances and their precursors in the San Joaquin River. The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on improving DO conditions. TMDLs for listed water bodies are proposed for completion in 2012 through 2021(State Water Resources Control Board 2011).

Actions that are being taken to address DO conditions in the Stockton Deep Water Ship Channel, or have assisted in improving DO conditions, include the construction of water aeration devices by the Port of Stockton at the confluence of the San Joaquin River and Stockton Deep Water Ship Channel and by DWR with a new aeration facility at the west end of the Port of Stockton docks in the Deep Water Ship Channel. DWR's aeration facility is much larger than the Port of Stockton system and injects pure oxygen into the Deep Water Ship Channel through a 200-foot-long diffuser during periods when DO conditions approach, or drop below, 5 mg/L. Testing of the facility during 2008–2010 indicates that the aeration facility can help prevent exceedances of the DO objectives but is not sufficient to prevent low DO under all possible upstream oxygen loading conditions (ICF International 2010). Additionally, the Stockton RWCF constructed nitrifying bio-towers that became operational in 2006, which, by converting ammonia to nitrate, reduce the historical ammonia loading rate and its associated oxygen demand to the San Joaquin River by about 90%.

8.1.3.7 Salinity and Electrical Conductivity

Background and Importance in the Study Area

Salinity is the concentration of dissolved salts in water. Typical salts found include the major cations (calcium, magnesium, sodium, and potassium) and anions (sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of the anions and cations are different in typical freshwater and seawater, with sodium and chloride dominating seawater salinity. The composition of dominant cations and anions in freshwater can vary to a much greater degree. Salinity can be measured in a variety of ways, including chloride concentration, TDS concentrations, and EC. While a recognized international measurement scale of salinity exists (Practical Salinity Units), the term is not commonly used, and the measured parameters EC and TDS are more often used interchangeably to refer to generalized effects of salinity. The beneficial uses most affected by salinity concentrations are municipal, agricultural, and industrial water supply.

Additionally, changes in salinity, including tidally influenced interfaces between freshwater and saltwater in the Delta, directly affect aquatic organisms and indirectly affect aquatic and wildlife habitats (warm freshwater habitat, cold freshwater habitat, estuarine habitat). Related beneficial uses such as commercial and sport fishing and shellfish harvesting also are affected.

EC and TDS values tend to be highly correlated because the majority of chemicals that contribute to TDS are charged particles that impart conductance of water. EC often is used to measure salinity because a simple electronic probe can measure salinity directly in the field and be recorded at frequent intervals (e.g., every 15 minutes), making it a cost-effective measurement. Other measures require field collection of water samples and laboratory analysis, which can be expensive. EC units commonly used are micromhos per centimeter (μmhos/cm) and milliSiemens per centimeter (mS/cm, and both are measures of the conductivity of the water.

Salinity can originate from natural sources such as seawater and rainfall-induced leaching of salts from soils. Anthropogenic sources of salinity include drainage from irrigated agricultural lands and managed wetlands, agricultural chemical soil additives, municipal and industrial wastewater discharges, and urban stormwater. Salinity also increases through evaporative concentration, which occurs during the dry, warm months of the year in ditches, canals, and reservoirs. Also, when excess water is applied to land for crop irrigation, the excess runs off to drainage ditches where it can be subject to evaporative concentration. Concern about salinity involves three main issues: drinking water, crop irrigation, and biota/habitat. Elevated concentrations of salinity result in poor-tasting water and also limit the ability to recycle wastewater for nonpotable uses (e.g., landscape irrigation). The TDS concentration of water from Sierra Nevada streams is typically less than 100 mg/L, while drinking water from the Delta typically has TDS concentrations from 150 to 300 mg/L, with concentrations occasionally exceeding 500 mg/L (CALFED Bay-Delta Program 2007a). Bromide, a constituent most commonly found in seawater and marine sediments, is a precursor to the formation of DBPs in drinking water facilities, which can be harmful to humans and animals (see Section 8.1.3.3 for a detailed discussion of bromide). In addition, industrial processes that require low-salinity water can be negatively affected. Salt removal during the water purification process (for either drinking or process water) is presently very expensive.

When salinity concentrations in irrigation water are too high, yields for salt-sensitive crops may be reduced. Salinity can decrease water available to the plant and cause plant stress (CALFED Bay-Delta Program 2007a). There are also fish, wildlife, and aquatic plant species that have adapted to naturally occurring salinity ranges in the Bay-Delta system, with specific salinity requirements at certain life stages in order to survive. There is evidence to suggest that the artificial stabilization of salinity, which has been undertaken in the Delta to maximize drinking and agricultural water quality, may create habitat more suitable for invasive species than for native species (Lund et al. 2007).

The primary source of salinity in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000), which occurs at greater magnitudes when Delta outflow to San Francisco Bay is low. Salinity also is elevated in the San Joaquin River inflows as a result of irrigated agricultural drainage on southern San Joaquin Valley soils of marine origin that are naturally high in salts, and from salt in

Delta waters that are used for irrigation and returned back to the Delta. From a broad viewpoint, salinity is determined as interplay between the amount of freshwater entering the Delta from the major tributaries (e.g., Sacramento and San Joaquin Rivers) and seawater from San Francisco Bay. During the late winter and spring months of seasonally elevated runoff and flows, and in particular during wet years with high levels of runoff from interior California, the elevated freshwater flows limit the extent of seawater intrusion into the Delta from the Bay. During low-flow summer and fall months, and dry water-year types with low levels of runoff, the lower freshwater flows result in greater amounts of seawater intrusion (Figures 8-4 and 8-5). Maximum salinity intrusions into the study area from the Bay are greatest during low-precipitation years.

The volume of Delta channels subject to daily tidal action is an important factor affecting the extent of high-salinity seawater intrusion and also influences the behavior of saline water once in the Delta. As described above, salinity in the Suisun Marsh channels are similarly affected by tidal seawater intrusion, and the SMSCG facilities and operations were developed in the late 1980's in response to the need to better manage changing salinity conditions. Increases in channel volume associated with levee failures on Delta islands (Mierzwa and Suits 2005) can result in daily tidal exchange moving considerably farther inland compared to conditions with the island levees intact. The June 2004 failure of a levee at Jones Tract, which flooded both upper and lower Jones Tract, resulted in substantial increased salinity conditions in the southern and central Delta (Mierzwa and Suits 2005).

The description of salinity in the Delta provided above is intended as an overview; salinity in the Delta can vary greatly in time and space (CALFED Bay-Delta Program 2007a) with many contributing factors, including those following.

- Hydrology (precipitation and runoff).
- Water operations (reservoir releases, channel barrier operations, diversion pumping rates).
- Watershed sources (agriculture, managed wetlands, natural leaching, municipal and industrial discharges).
- Hydrodynamics (geometry of water bodies, meteorology, salinity gradients, freshwater inputs, tidal action).

Existing Conditions in the Study Area

During the water year 2001–2006 period, mean EC concentrations tended to increase from the northern Delta to the southern Delta, and from the eastern Delta to the western Delta (Figure 8-24). For example, EC mean concentrations in the northern Delta were 166 and 141 µmhos/cm for the Sacramento River at Hood and the Mokelumne River (South Fork) at Staten Island, respectively. In the southern Delta region, EC mean concentrations were 590 and 673 µmhos/cm for the San Joaquin River at Buckley Cove and the San Joaquin River near Vernalis, respectively. As water exits the Delta, mean EC concentrations were 3,481 and 2,366 µmhos/cm for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel, respectively. Mean EC concentrations increased to 4,920 µmhos/cm at the Sacramento River at Mallard Island and were highest at Suisun Bay at Bulls Head Point near Martinez, with a value of 19,331 µmhos/cm.

Mean values for the north-of-Delta area were lower than in the Delta region, ranging from 65 µmhos/cm at the American River at the WTP to 120 µmhos/cm at the Sacramento River at Verona (Table 8-13). South-of-Delta mean values were higher than those for the north-of-Delta stations examined (439 to 460 µmhos/cm), and slightly higher than the mean at the Banks headworks (393 µmhos/cm) (Figure 8-24).

Table 8-13. Electrical Conductivity Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006

	Electrical Conductivity (µmhos/cm)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	82	127	106	108
Sacramento River at Verona	15	92	148	120	117
Feather River at Oroville	29	53	239	86	83
American River at WTP	120	6	152	65	65
California Aqueduct at Check 13	69	217	981	460	465
California Aqueduct at Check 29	74	133	680	439	456

Source: California Department of Water Resources 2009b.

Notes: µmhos/cm = micromhos per centimeter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that EC concentrations at the examined stations generally fluctuate on an annual basis (Figures 8-25a, 8-25b, and 8-26). However, peak values occurred at different times of the year for the various locations. Factors influencing this variability may include hydrology, water operations, watershed sources, and hydrodynamics in the Delta.

Because EC is not a priority pollutant, there are no criteria established for EC in the NTR or CTR. The secondary MCL for EC is specified as a range: 900 microSiemens per centimeter (µS/cm) (1 µS/cm=1 µmhos/cm) (recommended), 1,600 µS/cm (upper), and 2,200 µS/cm (short-term), and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The Region 5 Basin Plan specifies EC objectives for the Sacramento River, Feather River, and San Joaquin River; it also contains EC objectives for the Delta, which have been superseded by the 2006 Bay-Delta WQCP. The Bay-Delta WQCP contains EC objectives for the Delta for agricultural and fish and wildlife beneficial use protection, which vary by month and water-year type (see Appendix 8A, *Water Quality Criteria and Objectives*). The Bay-Delta WQCP EC objectives for agricultural protection are designed primarily to control salinity conditions in the interior and southern Delta channels, and San Joaquin River inflow to the Delta at Vernalis, which tend to have higher salinity concentrations and are influenced most by Delta exports. A contract between DWR and the North Delta Water Agency specifies that DWR will operate the SWP to achieve specified EC levels at certain Delta locations that, a minimum, must be equal to or better than the State Water Board's Bay-Delta WQCP EC objectives (California Department of Water Resources 1981).

Table 8-13a summarizes the record of compliance with the Delta EC objectives that are specified in the Bay-Delta WQCP. The compliance record indicates that with the exception of a 35 day period at the Sacramento River at Emmaton location during the severe drought of 2013, Delta water supply operations have been able to maintain compliance with the agricultural EC objectives in the interior and western Delta locations and all fish and wildlife EC objectives. The south Delta EC objectives have been exceeded at the San Joaquin River at Brandt Bridge, Old River at Tracy Bridge, and Old River at Middle River locations for various lengths of time in several years. Water quality in the southern Delta downstream of Vernalis is influenced primarily by San Joaquin River inflow; tidal action; agricultural return flows; and channel capacity. The Delta water supply operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis as evidenced by the comparatively lower EC levels at Vernalis and the Banks and Tracy export locations.

Table 8-13a. Summary of Compliance with Delta Electrical Conductivity Objectives (1995–2014)

	Objective[a, b]		Exceedances of Objective		
Location	Applicable Period and narrative description	Days/ Year[c]	Years with Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded [d]
Agricultural Water Supply Objectives					
Sacramento River at Emmaton	Apr 1–date end varies by WY 14-day avg EC varies by WY	137	1	35	35
San Joaquin River at Jersey Point	Jun 1–period end varies by WY 14-day avg EC varies by WY	76	0	0	0
SF Mokelumne at Terminous	Apr 1–Aug 15 14-day avg EC varies by WY	137	0	0	0
San Joaquin River at San Andreas	Apr 1–date end varies by WY 14-day avg EC varies by WY	137	0	0	0
Old River at Tracy	Apr 1–Aug 31 30-day avg EC<= 0.7 mS/cm Sep 1–Mar 31 30-day avg EC<= 1.0 mS/cm	365	9	289	88
Old River at Middle River	Apr 1–Aug 31 30-day avg EC<= 0.7 mS/cm Sep 1–Mar 31 30-day avg EC<= 1.0 mS/cm	365	2	47	41
San Joaquin River at Brandt Bridge	Apr 1–Aug 31 30-day avg EC<= 0.7 mS/cm Sep 1–Mar 31 30-day avg EC<= 1.0 mS/cm	365	3	68	28
San Joaquin River at Vernalis	Apr 1–Aug 31 30-day avg EC<= 0.7 mS/cm Sep 1–Mar 31 30-day avg EC<= 1.0 mS/cm	365	0	0	0
CCF	Oct 1–Sep 30 Monthly avg EC<= 1.0 mS/cm	365	0	0	0
DMC at Tracy PP	Oct 1–Sep 30 Monthly avg EC<= 1.0 mS/cm	365	0	0	0

Location	Objective[a, b] Applicable Period and narrative description	Days/ Year[c]	Exceedances of Objective Years with Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded[d]
Fish & Wildlife Objective					
Chipps Island and Port Chicago	Feb 1–Jun 30 "X2" objective for EC (min days/month vary by PMI)	150	0	0	0
San Joaquin River between Jersey and Prisoners Points	Apr 1–May 31 14-day avg EC<= 0.44 mS/cm	61	0	0	0
Eastern Suisun Marsh (Sacramento River at Collinsville)	Oct 1–May 31 Monthly avg high tides EC varies by month.	243	0	0	0
Eastern Suisun Marsh (Montezuma Slough at National Steel)	Oct 1–May 31 Monthly avg high tides EC varies by month.	243	0	0	0
Eastern Suisun Marsh (Montezuma Slough near Beldon's Landing)	Oct 1–May 31 Monthly avg high tides EC varies by month.	243	0	0	0
Western Suisun Marsh (Chadbourne Slough)	Oct 1–May 31 Monthly avg high tides EC varies by month and deficiency period.	243	0	0	0
Western Suisun Marsh (Suisun Slough)	Oct 1–May 31 Monthly avg high tides EC varies by month and deficiency period.	243	0	0	0

Notes: Avg = average; CCF = Clifton Court Forebay; CCC = Contra Costa Canal; DMC= Delta-Mendota Canal; mS/cm = milliSiemens per centimeter; PP=Pumping Plant; PMI = previous month's Eight River Index; SF Mokelumne = South Fork Mokelumne River; WY= water year.

[a] This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

[b] Only partial description of objective provided; refer to Bay-Delta Water Quality Control Plan for full text of objective.

[c] Total number of days in year that requirement is applicable.

[d] Median calculated using only years when exceedances occurred.

The Region 2 Basin Plan contains agricultural EC objectives; however, the affected environment of the Delta and downstream Bay waters in Region 2 are generally saline and do not likely serve as a major water source for agricultural activity. For the protection of fish and wildlife habitat, the Bay-Delta WQCP regulates EC in western and interior Delta locations and Suisun Marsh.

The Central Valley Water Board and the State Water Board, in coordination with funding from the Central Valley Salinity Coalition, are overseeing the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program, which is a science, policy, and regulatory planning process that began in 2006 to address the long-term buildup of salts, including nitrates, throughout the Central Valley in a comprehensive, consistent, and sustainable manner. Through a collaborative multistakeholder process, the CV-SALTS program will result in development of a Central Valley Salt and Nutrient Management Plan (SNMP), along with Basin Plan amendments to implement the SNMP. A goal for CV-SALTS is to foster regional collaborations for more efficient and effective salinity and nutrient management from regulated discharges and actions beyond the jurisdiction of the Central Valley Water Board and State Water Board, such as regional salt storage or conveyance systems, treatment facilities, Real-Time Management, water or salt trading, or other actions that the regulators are unable to require, but which could facilitate sustainable salinity management in the region.

CV-SALTS prepared an updated strategy and workplan in February 2012 that identified necessary studies to develop the SNMP. CEQA scoping meetings were held in late 2013 to solicit comments on potential components of the Central Valley SNMP. CV-SALTS has completed many studies identified in the early planning stages for CV-SALTS, including review and evaluations of applicable and potential alternative salinity and nutrient regulatory policies and water quality objectives for beneficial use protection. Many more studies, including economic and environmental review of proposed SNMP alternatives, are underway. A Strategic Salt Accumulation Land and Transport Study (SSALTS) is being prepared to identify the range of viable salt disposal methods for the Central Valley (taking into account regulatory, institutional, economic, and technological issues) and inclusion in the SNMP. The SSALTS study will evaluate existing salt disposal areas, establishment of new salt disposal areas within the Central Valley, export or transport of salt out of the Central Valley, or some combination of the above. Two parts of the study have been completed to date including a "Phase 1" report in December 2013 of potential study areas, and a "Phase 2" report in October 2014 that identifies potential salt disposal options.

As envisioned by CV-SALTS, the major final phases to develop the SNMP by mid-2016 are as follows:

- Initial Conceptual Model (ICM): The ICM study report was prepared in August 2013 and provides an approximate water, salt, and nitrate load balance analysis for the Central Valley floor in 22 areas of analysis referred to as Initial Analysis Zones (IAZs). The analysis uses the USGS 2009 Central Valley Hydrologic Model (CVHM) model, coupled with the Watershed Analysis Risk Management Framework model, to evaluate TDS, chloride, and nitrate mass loading and transport in the Central Valley.
- Development of the Draft SNMP: This phase will utilize the data collected and/or organized as well as the methods and results developed as a part of the ICM. The Draft SNMP will provide refined spatial detail in some locations for the water balance, salt, and nitrate modeling of the Central Valley floor.
- Regulatory Approval Process: During this phase, the SNMP will be finalized and the documents that are necessary for the regulatory approval process for the adoption of the SNMP will be developed and submitted as a part of the Basin Plan Amendments.
- Development of Local SNMPs: It is anticipated that, upon completion of SNMP, focused SNMPs (Local SNMPs) may be developed and implemented by local and/or regional entities as needed.

Multiple water bodies in the affected environment are on the state's CWA Section 303(d) list for impairment by elevated EC levels, as follows: (a) southern, northwestern, and western channels in the Delta; (b) Delta export area; (c) Grasslands drainage area, Mud Slough, and Salt Slough in the San Joaquin River valley; (d) San Joaquin River from Bear Creek to Delta boundary; and (e) Suisun Marsh (State Water Resources Control Board 2011). A TMDL has been prepared for the lower San Joaquin River at Vernalis, and the TMDL for segments upstream from Vernalis is under development.

8.1.3.8 Emerging Pollutants: Endocrine-Disrupting Compounds, Pharmaceutical and Personal Care Products, and Nitrosamines

Background

Emerging water quality contaminants represent a broad range of chemicals that have not traditionally been part of monitoring programs because they were not deemed important until recently or the ability to quantify them had not been possible until recent laboratory advances allowed their detection. As such, data for these parameters in the study area are relatively sparse. The beneficial uses (Table 8-1)most directly affected by emerging pollutant concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) and drinking water supplies (municipal and domestic supply). The focus of the following section is on three classes of emerging contaminants: EDCs, PPCPs, and nitrosamines (e.g., NDMA).

Endocrine-Disrupting Chemicals

EDCs interfere with hormone (endocrine) systems in animals. Hormones are released by body organs (e.g., thyroid, ovaries, testes) and act as chemical messengers to other organs and tissues. Hormones bind with receptor sites in a way similar to how a key fits into a lock. Upon binding, the receptor carries out the hormone's instructions by either altering the cell's existing proteins or turning on genes that will build a new protein (U.S. Environmental Protection Agency 2009b). Both of these actions create reactions throughout the body. The hormone system operates from conception through old age, affecting development, reproduction, metabolism, and other crucial body functions.

The problem with EDCs is that they can bind to hormone receptor sites in the body. The effect of this action varies but usually involves altering the function of the hormone system (U.S. Environmental Protection Agency 2009b). For example, an EDC that mimics a natural hormone can result in over- or underproduction of a chemical or response (e.g., too much growth hormone) or generation of a response at an inappropriate time (e.g., producing insulin when not needed). Other EDCs can block natural hormones from binding. Overall, the action of EDCs is typically undesirable because EDCs can disrupt normal body function.

EDCs have been studied with respect to their potential impacts on aquatic organisms (e.g., Snyder 2003, 2008). For example, studies of the impact of estrogen exposure on fish downstream of WWTPs have detected elevated levels of vitellogenin, a female-specific egg yolk protein, in male fish. In a 7-year study, investigators found that concentrations of estrogens/estrogen mimics observed in freshwater could affect the sustainability of wild fish populations by altering the male population (Kidd et al. 2007).

Examples of EDCs include natural plant and animal compounds, metals (e.g., arsenic, cadmium, lead, mercury), dioxins, polycyclic aromatic hydrocarbons (PAHs), pesticides, PPCPs, and PCBs (Snyder 2008). Sources of anthropogenic EDCs include WWTPs, private septic systems, urban stormwater runoff, industrial effluents, landfill leachates, discharges from fish hatcheries and dairy facilities, runoff from agricultural fields and livestock enclosures, and land amended with biosolids or manure.

WWTPs are not specifically designed to treat and remove EDCs, and the WWTP industry is just beginning to examine their ability to treat for EDCs, with some degree of success (e.g., Snyder 2008; Benotti et al. 2009; Contra Costa Water District 2009); however, our understanding of treatability for CECs is incomplete. Related research suggests that estrogen compounds can be biodegraded in the stream sediments below plant outfalls (Bradley et al. 2009).

Pharmaceuticals and Personal Care Products

PPCPs generally represent products used by humans for personal health (e.g., prescription and over-the-counter drugs) or cosmetic (e.g., fragrances, lotions) reasons, as well as products used to enhance livestock growth or health (e.g., hormones, antibiotics).

PPCPs in the environment have not yet been shown to adversely affect human health, but some studies suggest that they contribute to ecological harm (U.S. Environmental Protection Agency 2009c). PPCPs have been found in most places sampled but typically at very low concentrations. Research to study the long-term exposure to very low PPCP concentrations is in its infancy. Concern exists because so much is unknown about the effects of PPCPs and because the number of PPCPs is growing.

According to the USEPA (2009c), people contribute PPCPs to the environment when medication residues pass out of the body and into sewer lines, when externally applied drugs and personal care products they use wash down the shower drain, and when unused or expired medications are placed in the trash or flushed down a toilet.

Municipal WWTPs are not specifically designed to treat and remove PPCPs; however, activated sludge treatment processes are known to exhibit PPCP treatment and removal effectiveness for many compounds. The Water Environment Federation has sponsored research that investigated factors of WWTP processes that result in PPCP removal performance (Oppenheimer and Stephenson 2006). The study evaluated monitoring data for 20 PPCP compounds in a variety of secondary biological and filtration treatment processes, including processes with nitrification and denitrification. The study determined that in general, an increase in solids residence time (SRT) was an important factor resulting in enhanced removal efficiency for the majority of the monitored chemicals. The SRT required to achieve consistent removal above 80% is compound-specific, with many of the target compounds well removed by activated sludge processes with SRTs of 5 to 15 days. Half of the 20 PPCP target compounds showed frequent occurrence in secondary influent, but were also efficiently removed (>80%) at SRT of less than 5 days, consisting of caffeine, ibuprofen, oxybenzone, chloroxylenol, methylparaben, benzyl salicylate, 3-phenylpropionate, butylbenzyl phthalate, and octylmethoxycinnamate. An SRT of more than 30 days was necessary to achieve 80% removal for certain compounds. Miège et al. (2009) evaluated PPCP removal performance based on monitoring data from 117 WWTPs and determined that PPCP removal efficiency was highest in facilities utilizing activated sludge with nitrogen removal processes. They determined that the main mechanisms involved in removal efficiency of the PPCPs were biodegradation (e.g., oxidation, hydrolysis, demethylation, cleavage of glucuronide conjugates), sorption on sludge or particulate matter (by hydrophobic or electrostatic interactions), and filtration.

Given the hundreds of EDCs and PPCPs that exist, determining which compounds to monitor presents a challenge (e.g., Hoenicke et al. 2007; de Voogt et al. 2009; Southern California Coastal Water Research Project 2009). National reconnaissance studies have keyed in on several dozen chemicals that are known to have or may have the potential to affect humans and wildlife.

The first nationwide study took place in 1999 and 2000 and examined 95 chemicals in 139 streams across 30 states (Kolpin et al. 2002). According to the study, the most frequently detected compounds were coprostanol (fecal steroid); cholesterol (plant and animal steroid); N,Ndiethyltoluamide (insect repellant); caffeine (stimulant); triclosan (antimicrobial disinfectant); tri(2-chloroethyl) phosphate (fire retardant); and 4-nonylphenol (nonionic detergent metabolite). In a follow-up study, the most frequently detected chemicals targeted in surface water were cholesterol, metolachlor (herbicide), cotinine (nicotine metabolite), and β-sitosterol (natural plant sterol).

Nitrosamines

Nitrosamines are a family of semi-volatile organic chemicals containing a nitroso and an amine functional group. N-Nitrosodimethylamine (NDMA) is the best-known nitrosamine, although there are several others of importance, including N-Nitrosodiethylamine (NDEA) and N-Nitrosodi-n-propylamine (NDPA). Chlorination or chloramination of water containing organic-nitrogen, such as occurs during water and wastewater treatment, can lead to the production of NDMA and other nitrosamines. NDMA and other nitrosaminesalso can form or be leached during treatment of water by anion exchange resins. NDMA and other nitrosamines are not easily removed during treatment, as they do not readily biodegrade, adsorb, or volatilize (Najm and Trussell 2001).

NDMA has been used in the production of liquid rocket fuel, and in a variety of other industrial uses. It has been found in foods, beverages, drugs, and tobacco smoke (National Toxicology Program 2011). NDMA and other nitrosamines can cause cancer in laboratory animals. The USEPA classifies a number of them as probable human carcinogens. In 2006, the Office of Environmental Health and Hazard Assessment established a public health goal of 3 nanograms per liter (ng/L) for NDMA. The DPH also has a 10 ng/L notification level for several nitrosamines, including NDMA. (http://www.cdph.ca.gov/certlic/drinkingwater/pages/NDMA.aspx accessed 4-23-12)

Importance in the Study Area

Studies of EDCs and PPCPs in California waters are, like the national studies, typically less than 10 years old. A few of these studies are highlighted in the following sections.

In 2001 and 2002, a survey of raw and treated drinking water from four water filtration plants in San Diego County showed the occurrence of several PPCPs including phthalate esters, sunscreens, clofibrate, clofibric acid, ibuprofen, triclosan, and DEET (Loraine and Pettigrove 2006). This is important because on average, roughly a third of the water in San Diego County originates from the Delta via conveyances of the SWP. According to the study, occurrence and concentrations of these compounds were highly seasonally dependent, and reached maximums when the flow of the San Joaquin River was low and the quantity of imported water was high. The maximum concentrations of the PPCPs measured in the raw water were correlated with low-flow conditions in the Delta that feed the SWP.

Sampling in the Bay-Delta system in 2002 and 2003 resulted in detection of several EDCs and PPCPs (Hoenicke et al. 2007). In this study, the authors reported flame-retardant compounds, pesticides and insecticide synergists, insect repellents, PPCPs, plasticizers, non-ionic surfactants, and other manufacturing ingredients in water, sediment, and biological tissue samples. Several of these compounds, especially polybrominated diphenyl ether flame retardants, exhibited concentrations of environmental concern. The highest tissue concentrations of total polybrominated diphenyl ethers in bivalves (oysters, mussels, and clams) were detected in samples near the outlets of the Sacramento and San Joaquin Rivers. Another study evaluated the occurrence and fate and transport of 33 target analytes representing EDCs, PPCPs, and other organic chemicals in wastewater from quarterly samples (April 2008–2009) collected at 11 locations in the Sacramento River, Delta, and California Aqueduct, along with similar watershed sample locations from the Santa Ana River and imported Colorado River water distribution systems in southern California (Guo et al. 2010). With the exception of the American River sample, all of the Sacramento River/Delta/Aqueduct sample locations had one or more target analytes detected. The median concentration of individual analytes was <30 ng/L, except for diuron (81 ng/L), an agricultural pre-emergent herbicide that is used extensively in the region. Maximum concentrations for some analytes exceeded 100 ng/L. The study determined that analyte concentrations were generally lower in locations upstream of domestic WWTPs, indicating that wastewater effluent discharges are the likely dominant sources of most PPCPs detected.

A preliminary screening study of surface waters along the northern California coast and the Central Valley took place between 2003 and 2005 to determine whether chemicals associated with agricultural and urban land uses could be potential sources of EDCs (de Vlaming et al. 2006). The authors concluded that there was no strong estrogenic activity equivalent to assay positive control.

In 2006, CCWD participated in a study to examine the toxicological relevance of EDCs and PPCPs in both raw source and treated water (Contra Costa Water District 2009). Of the 62 compounds analyzed, only five were detected in the treated water: sulfamethoxazole (pharmaceutical), meprobamate (pharmaceutical), atrazine (herbicide—endocrine disruptor), triclosan (pharmaceutical), and dioctyl phthalate (used to make plastics—endocrine disruptor). The study concluded that detection occurred at low concentrations and should not pose any health threats.

Regarding nitrosamines, while several studies have examined NDMA and other nitrosamine formation in water and WWTPs, few studies have examined NDMA or other nitrosamines in the study area. A study conducted in the Delta concluded that locations downstream of WWTPs had the highest levels of NDMA precursors, as measured by NDMA formation potential, although actual NDMA concentrations were low. Formation potential as a result of diuron in the samples was low (DiGiorgio 2009).

Existing Conditions in the Study Area

Data for most EDCs, PPCPs, and nitrosamines in the Delta and the north- and south-of-Delta locations are very sparse because most compounds are not typically part of water quality sampling programs. The aforementioned studies represent the most current information on the monitoring of these compounds in the Delta. This reality lead EPA to recently conclude in its Advanced Notice of Proposed Rule Making regarding water quality challenges in the Delta, “Although there is not sufficient data in the published literature to adequately assess the ecological implications of these compounds in the Bay Delta Estuary, there is ample evidence to warrant additional attention” (U.S. Environmental Protection Agency 2011:48). As such, EPA included emerging contaminants on its list of likely stressors affecting aquatic resources in the Delta (U.S. Environmental Protection Agency 2011:20, 48; 2012a:3).

Regulatory criteria with respect to emerging pollutants are as follows. Numerical water quality objectives for the CTR, Central Valley Water Board Basin Plan, San Francisco Bay Water Board Basin Plan, or California drinking water MCLs for pollutants that act as EDCs are discussed in previous constituent subsections: mercury, other trace metals, dioxins, PAHs, PCBs, and pesticides. Listings for emerging pollutants on the Section 303(d) list are limited to these aforementioned subsections as well. With regard to Basin Plan narrative objectives, emerging pollutants might fall under the *population and community ecology* or *toxic* categories. Finally, in addition to the aforementioned DPH public health goal (3 ng/L for NDMA) and notification levels for some nitrosamines, three nitrosamines (NDMA, NDPA, and N-Nitrosodiphenylamine) are listed in the CTR (0.00069, 0.005, 5.0 µg/L, respectively, for consumption of water and organisms).

8.1.3.9 Mercury

Background

Mercury and its more biologically available methylated form is an element of statewide concern. Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay today is derived both from current processes and as a result of historical deposition. The majority of the mercury present (and hence the impacts on beneficial uses) is the result of historical mining of mercury ore in the Coast Ranges (via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers) (Alpers et al. 2008:6; Wiener et al. 2003). Residual mercury in soils affected by historical mining continues to contribute to mercury concentrations in water and sediments of the Delta and its tributaries. The mercury supplied from historical gold mining processes appears to be the most bioavailable of the two primary sources because that mercury was purified prior to use rather than left as more refractory ore and tailings (Central Valley Regional Water Quality Control Board 2008a).

The bioavailability and toxicity of elemental mercury (from whatever primary source) are greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands or wetlands. These environments tend to be more stagnant, with reduced oxygen concentrations, and promote chemical reduction processes that make methylation possible.

Areas of enhanced bioavailability and toxicity of mercury (created through the mercury methylation process) exist in the Delta, and elevated methylmercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife. Consequently, the beneficial uses (Table 8-1) most directly affected by mercury are shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and rare, threatened, and endangered species resources that can be exposed to bioaccumulation of mercury. Because of these concerns, mercury was the first TMDL approved for San Francisco Bay in 2007 (San Francisco Bay Water Board 2006). The Delta methylmercury TMDL was approved by the Central Valley Water Board in 2010 and was approved as final on October 20, 2011 (Central Valley Regional Water Quality Control Board 2011b). The Delta, several direct tributaries to the Delta (i.e., Sacramento River, San Joaquin River, Mokelumne River, Putah Creek, and Calaveras River), and areas downstream (i.e., Suisun Bay and Suisun Marsh) also are listed as impaired water bodies on the Section 303(d) lists for mercury in fish tissue (State Water Resources Control Board 2011).

Importance in the Study Area

Limiting characterization to the routine monitoring of total mercury waterborne concentrations is inadequate to determine mercury bioavailability. A conceptual model is needed to determine the importance of sediment, fish tissue, and methylated mercury as measures of exposure and risk in the system. A description of this model follows, and then concentrations in sediment and fish tissues are detailed.

Conceptual Model of Mercury and Methylmercury Transport and Fate in the Delta

Several conceptual models have been created for the Delta to describe important linkages among waterborne loading, waterborne concentrations, and water, sediment, and biotic processing of mercury and methylmercury (Ecosystem Restoration Program Delta Regional Ecosystem Restoration Implementation Plan [ERP DRERIP]). Figure 8-27 shows the important linkages, pathways, and relative importance of each in determining bioavailability; the important links between sediment processes and biotic uptake are emphasized. Mercury is strongly particle-associated and tends to settle and accumulate in sediment deposition areas, where, if conditions are favorable, can facilitate mercury methylation by sulfur-reducing bacteria. From that point in the cycle, diet (rather than waterborne concentration) is the primary route for methylmercury exposure to fish, wildlife, and humans. Refer also to Chapter 25 (Public Health) for discussion of the effects of mercury to human health.

The goal of mercury conceptual models (such as Alpers et al.2008:ii) and plans created for integrated mercury investigations as part of Delta restoration efforts (such as Wiener et al. 2003) has been to identify linkages that can be used to guide restoration efforts toward the least harmful alternatives (the alternative with the least potential to exacerbate mercury-related effects). Aside from controlling upstream sources of mercury and methylmercury loading to the Delta, it may be important to limit the conversion of mercury to the more bioaccumulative and toxic methylmercury in Delta environments. For that reason, the Central Valley Water Board has focused on controlling methylmercury to protect beneficial uses in the Delta (Central Valley Regional Water Quality Control Board 2008b). As shown in Figure 8-27, a series of drivers related to water quality and sediment determines methylmercury production and uptake in biota and subsequent health effects on humans or wildlife. At every step of the process, opportunities exist to modify final outcomes and minimize impacts from mercury toxicity.

As suggested in Figure 8-27 and summarized from the local and general literature (as discussed and cited in Alpers et al. 2008), the following environmental characteristics are most important for determining risks to fish, wildlife, and humans from waterborne mercury contamination in the Delta.

- Source of mercury (atmospheric and gold mining operations are most bioavailable).
- Nutrient enrichment (high nutrient supply, algal growth, and eutrophication favor mercury uptake, bioaccumulation, and methylation).
- Water column DO (oxygen depletion in water or surface sediments favors methylation).
- Sediment organic content and grain size (small size fractions and more organic characteristics favor methylation).
- Water residence time and sediment accumulation (high residence time and sediment deposition areas favor methylation).
- Periodic drying and wetting (seasonal or annual flooding enhances methylmercury production and food chain bioaccumulation in certain areas of the Delta) (Slotton et al. 2007).
- Fish species and age structure (top predators and older, larger fish accumulate higher tissue concentrations of methylmercury).

Although sulfate could affect rates of mercury methylation (due to the dependence on sulfate-reducing bacteria for methylation), such a relationship is highly variable and site-specific and not a good predictor of methylation potential. The environmental factors governing rates of methylation are complicated and site-specific modeling is required (Moore et al. 2003). Although sulfate can be important to the rate of mercury methylation (Gilmour et al. 1992), intermediate levels may be more stimulatory than low or high concentrations (Shao et al. 2012). Furthermore, experiments have revealed that sulfate supply does not always directly relate to rates of methylation (Johnson and Beck 2012). In contrast, the importance of low DO and availability of organic carbon is well known (Alpers et al. 2008; Gorski et al. 2007), as well as the necessary supply of inorganic mercury (Shao et al. 2012). In addition, the availability of dissolved mercury may be determined by the availability of solid FeS (Han et al. 2007). For these reasons, waterborne sulfate, by itself, is not considered a reliable predictor of mercury methylation potential or correlated to methylmercury concentrations.

Existing Conditions in the Study Area

Water Concentrations

Water quality data from the Delta and Suisun Marsh include records of mercury and methylmercury waterborne concentrations as total or filtered water fractions. Water quality summary information since 1999 is shown in Table 8-14. The general pattern of mercury waterborne loading to the Delta shows the dominance of mercury mining sources via Cache Creek and the Yolo Bypass (Central Valley Regional Water Quality Control Board 2008b); however, the waterborne average concentrations do not reflect the same pattern as loads (Table 8-15). Instead, the eastside tributaries and San Joaquin River show higher mercury and methylmercury concentrations than the Sacramento River inputs. In general, waterborne concentrations of total mercury fall below regulatory guidelines while most of the mean methylmercury concentrations throughout the Delta exceed the Regional Board TMDL concentration guidelines of 0.06 ng/L (Table 8-14).

Sediment Concentrations

It has been estimated that the flux of methylmercury from Delta sediments contributes up to 36% of the waterborne methylmercury load in the Delta (Central Valley Regional Water Quality Control Board 2008a). Therefore, the spatial variability of mercury and methylmercury in sediments is an important characteristic of the Delta's current condition for mercury exposure and could be important for determining future mercury risk. Table 8-15 shows the pattern of surface sediment mercury throughout the Delta and Suisun Bay. The data is presented to show the pattern of mercury deposition and to aid future planning, but sediment data (in contrast to water and fish) is not modeled as part of this evaluation of future conditions for project alternatives.

The CALFED sediment mercury study reported that total mercury in sediments varied spatially but not seasonally (Heim et al. 2007). Total mercury concentrations (the sum of elemental and methylmercury) in sediment were most elevated in the influent tributary streams and Suisun Bay compared to the central and southern Delta.

In contrast, methylmercury showed both spatial and seasonal variations in concentration. The biologically mediated nature of mercury methylation was apparently important in creating a seasonal summer maximum in sediment methylmercury concentrations. Methylmercury concentrations were highest in the mid-Delta interior marshes (compared to peripheral rivers) and varied on a small scale, with the highest concentrations in mid-marsh.

The pattern of mercury transport and fate in the Delta is one of waterborne loading from historical source waters (and runoff from historically affected soils) to the interior Delta, followed by the accumulation of fine sediments in the marsh and subsequent methylation of elemental mercury in those locations (Heim et al. 2007).

Fish Tissue Concentrations

Resident Delta fish accumulate mercury primarily through dietary exposure; larger, piscivorous (fish-eating) fish show the greatest levels of tissue mercury. In contrast to anadromous fish (migratory species), the resident fish experience constant exposure to local mercury sources. Resident species include larger fish with human health exposure (such as largemouth bass) and smaller, forage fish (such as inland silversides). Fish tissues are the ultimate route of exposure to mercury for aquatic-dependent birds and mammals, and for humans who consume locally caught fish.

The mercury conceptual model illustrates these principles. Human health and wildlife health effects resulting from mercury exposure and uptake are the final outcomes of the mercury conceptual model (Figure 8-27). Available data show substantial levels of mercury contamination in fish throughout the Delta. For example, the tissue concentrations of mercury in largemouth bass are shown as a spatial distribution throughout the Delta in Figure 8-28 (1999–2000 data). Note that the Mokelumne River, Cosumnes River, Sacramento River, and San Joaquin River inflows exhibit the highest fish tissue bioaccumulation, whereas these larger sport fish had uniformly lower tissue concentrations in the central Delta.

Larger, piscivorous resident fish, in general, provide a good record of fish tissue mercury as a baseline condition for the Delta. Largemouth bass were chosen because they are popular sport fish, top predators, live for several years, and tend to stay in the same area (exhibit high site fidelity). Consequently, they are excellent indicators of long-term average mercury exposure, risk, and spatial pattern for ecological and human health. Results from a study of mercury in sport fish from the Delta region found the median largemouth bass tissue mercury concentration to be 0.53 mg mercury per kilogram (Hg/kg) wet weight (Davis et al. 2008). Recent summaries from tributary inputs to the Delta reveal average bass concentrations similar to or higher than this Delta-wide average (Table 8-16).

Current fish tissue concentrations thus exceed both adopted regulatory standards and guidance from the USEPA. In the draft Delta TMDL for methylmercury, the Central Valley Water Board has recommended fish tissue goals (fillet concentrations, wet weight mercury) of 0.24 mg Hg/kg wet weight in trophic level 4 fish (adult, top predatory sport fish, such as largemouth bass) (Central Valley Regional Water Quality Control Board 2008b). These values are slightly lower than USEPA's national recommended water quality criterion for fish tissue of 0.3 mg Hg/kg wet weight for protection of human health and wildlife (U.S. Environmental Protection Agency 2001). Therefore, the Delta average for largemouth bass fillet concentrations in the study by Davis et al. exceeds both recommended safe consumption guidelines.

Table 8-14. Mercury and Methylmercury Surface Water Concentrations at Tributary Inputs and the Delta's Major Outputs

	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
Site	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Mercury Concentrations for Tributary Inputs												
Sacramento River at Keswick	26	0.2	2.7	0.5	2006–2007	DWR 2010	–	–	–	–	–	–
Sacramento River at Keswick[a]	–	–	–	–	–	–	–	–	–	–	–	–
Feather River at Oroville	5	0.2	0.7	0.4	2006–2007	DWR 2010	–	–	–	–	–	–
Feather River at Oroville[a]	–	–	–	–	–	–	–	–	–	–	–	–
Sacramento River at Verona	5	0.8	2.6	1.6	2006–2007	DWR 2010	–	–	–	–	–	–
Sacramento River at Verona[a]	–	–	–	–	–	–	–	–	–	–	–	–
Sacramento River at Freeport	45	1.2	30.6	4.1	1999–2002	Central Valley Water Board 2008a	36	0.05	0.24	0.10	2000–2003	Central Valley Water Board 2008a
Sacramento River at Freeport[a]	0	–	–	–	–	–	1	0.03	0.03	0.03	2000	Central Valley Water Board 2008a
San Joaquin River at Vernalis	49	3.1	21.7	7.6	2000–2004	BDAT 2010; Central Valley Water Board 2008a	49	0.09	0.26	0.15	2000–2001, 2003–2004	BDAT 2010; Central Valley Water Board 2008a
San Joaquin River at Vernalis[a]	19	0.3	3.0	0.8	2000–2002	BDAT 2010; USGS 2010	25	0.01	0.08	0.03	2000–2002	BDAT 2010; Central Valley Water Board 2008a; USGS 2010
Mokelumne River at Interstate 5	21	0.3	12.0	4.5	2000, 2001, 2003	Central Valley Water Board 2008a	23	0.02	0.32	0.12	2000, 2001, 2003	Central Valley Water Board 2008a
Mokelumne River at Interstate 5[a]	0	–	–	–	–	–	8	0.02	0.17	0.06	2000	Central Valley Water Board 2008a
Cosumnes River at Michigan Bar[a]	1	1.4	1.4	1.4	2002	USGS 2010	1	0.41	0.41	0.41	2002	USGS 2010
Calaveras River at Rail Road upstream of West Lane	4	13	26	20	2003–2004	Central Valley Water Board 2008a	4	0.11	1.9	0.14	2003–2004	Central Valley Water Board 2008a

Site	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Mercury Concentrations for Delta's Major Outputs												
Delta-Mendota Canal at Byron Highway	23	1.9	6	3.3	2000, 2001, 2003	Central Valley Water Board 2008a	21	0.01	0.17	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
Delta-Mendota Canal at Byron Highway[a]	0	–	–	–	–	–	8	0.02	0.09	0.03	2000	Central Valley Water Board 2008a
SWP	20	1.2	7.2	2.5	2000, 2001, 2003	Central Valley Water Board 2008a	20	0.01	0.14	0.04	2000, 2001, 2003	Central Valley Water Board 2008a
SWP[a]	0	–	–	–	–	–	8	0.02	0.08	0.03	2000	Central Valley Water Board 2008a
X2	20	4	49	15	2000, 2001, 2003	Central Valley Water Board 2008a	22	0.007	0.24	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
X2[a]	0	–	–	–	–	–	8	0.02	0.06	0.03	2000	Central Valley Water Board 2008a
Suisun Bay	34	2.52	35.24	9.43	2000–2008	SFEI 2010	36	8E-05	0.18	0.03	2000–2008	SFEI 2010
Suisun Bay[a]	35	0.16	4.80	0.84	2000–2008	SFEI 2010	32	8E-05	0.10	0.01	2000, 2002–2008	SFEI 2010
California Aqueduct Check 13	–	–	–	–	–	–	–	–	–	–	–	–
California Aqueduct Check 13[a]	36	0.2[b]	0.2[b]	0.2[b]	2000–2005	DWR 2010	–	–	–	–	–	–
California Aqueduct Check 29	–	–	–	–	–	–	–	–	–	–	–	–
California Aqueduct Check 29[a]	152	0.2[b]	0.2[b]	0.2[b]	2000–2010	DWR 2010	–	–	–	–	–	–

Sources: Bay Delta and Tributaries Project (BDAT) 2010; Central Valley Regional Water Quality Control Board 2008a; California Department of Water Resources (DWR) 2010; San Francisco Estuary Institute (SFEI) 2010; U.S. Geological Survey (USGS) 2010.

Notes: Max. = maximum; Min. = minimum; ng/L = nanograms per liter.

[a] Dissolved concentration of analyte.

[b] It is assumed that the units were reported incorrectly for the site.

Table 8-15. Mercury and Methylmercury Sediment Concentrations for Tributary Inputs, the Delta, and Suisun Bay

Site	Sample Type	Total Mercury (ng/g Dry Weight)					Methylmercury (ng/g Dry Weight)				
		Samples	Min.	Max.	Mean	Year	Samples	Min.	Max.	Mean	Year
Concentrations at Tributary Inputs											
Sacramento River, Freeport[a]	Colloid	4	140	290	208	1996–1997	–	–	–	–	–
Sacramento River, Freeport[a]	Bed Sediment	1	267	267	267	1996–1997	–	–	–	–	–
Concentrations in Delta and Suisun Bay											
North Delta[b]	Surficial Sediment	11	104	320	170	1999	11	0.12	0.64	0.35	1999
East Delta[b]	Surficial Sediment	12	10.5	340	110	1999	9	0.02	0.68	0.3	1999
Central and West Delta[b]	Surficial Sediment	15	10.5	370	77	1999	12	0.019	1.1	0.36	1999
Central and West Delta[c]	Surficial Sediment	18	16.5	417	106	2000–2008	18	0.02	0.7	0.11	2000–2008
Suisun Bay[b]	Surficial Sediment	21	66	580	270	1999	20	0.019	9.3	0.45	1999
Suisun Bay[c]	Surficial Sediment	69	0.03	413	114	2002–2007	69	0.004	0.82	0.13	2000–2008

Sources: Heim et al. 2007; San Francisco Estuary Institute 2010; U.S. Geological Survey 2009.

Notes: Max. = maximum; Min. = minimum; ng/g = nanograms per gram.

[a] Source: U.S. Geological Survey 2009.

[b] Source: Heim et al. 2007.

[c] Source: San Francisco Estuary Institute 2010.

Table 8-16. Mercury Concentrations in Largemouth Bass Fillets for Tributary Inputs

		Length (mm)			Concentration (mg Hg/kg Wet Weight)			
Site	Fish	Min.	Max.	Mean	Min.	Max.	Mean	Year
San Joaquin River at and downstream of Vernalis	40	226	530	325	0.21	1.4	0.56	1998–2000
Mokelumne River downstream of Cosumnes River	22	210	425	331	0.31	1.6	0.83	1999–2000
Cosumnes River	19	201	485	329	0.34	2.1	0.87	1999–2000

Source: Central Valley Regional Water Quality Control Board 2008a.

Notes: Max = maximum; mg Hg/kg = milligrams mercury per kilogram; Min = minimum; mm = millimeters.

Surprisingly, spatial patterns of mercury bioaccumulation in larger piscivorous sport fish do not show a clear link to zones of active sediment methylation in the Delta. In the study by Davis et al., the highest levels of fish tissue concentrations were found in the north Delta, Cosumnes River, and San Joaquin River, and lower fish tissue concentrations were found in the central, marsh-like Delta locations (Davis et al. 2008). The pattern reflects the dominance of source waters carrying methylmercury as a driver of increased fish tissue concentrations relative to the contribution from areas of secondary methylation in marshy locations or wetlands. In fact, in a related comprehensive study of Delta sport fish (including largemouth bass), mercury concentrations in fish tissues were found not to directly relate to the presence of wetlands. The authors found that the data "contradicted the prevailing notion that wetlands generally increase methylmercury accumulation in the food web" (Melwani et al. 2007). Nevertheless, the authors acknowledged the complexity of developing such relationships on a watershed scale; small-scale local factors may be the most important determinants of mercury bioaccumulation. In a subsequent study, the same authors suggest that in the case of the Delta, waterborne methylmercury may be a more important determinant of fish bioaccumulation than sediment mercury and the associated sites where methylation occurs (Melwani et al. 2009). Furthermore, laboratory studies of mercury uptake in Delta species indicate that much higher assimilation and uptake were observed in waters of lower DOC (as might be expected from the tributaries versus the interior Delta) (Pickhardt et al. 2006). This finding may help explain the dissimilar spatial pattern between sediment and fish methylmercury concentrations in the areas studied; waterborne methylmercury loading may be more important than sediment methylation in explaining the patterns of fish mercury bioaccumulation in the Delta.

In addition to human exposure as estimated from large-fish monitoring, the monitoring of whole-body fish tissues from various smaller species provides slightly different information. Monitoring of these so-called *biosentinel species*, such as inland silversides, prickly sculpin, and juvenile largemouth bass, demonstrates the variation in mercury bioaccumulation over small spatial scales and seasonal time frames (Slotton et al. 2007). The fish were juveniles of predatory fish or were various short-lived, smaller species and exhibited high site fidelity; thus, they were good monitors of spatial patterns and short time exposure. These fish were also good indicators of short-term seasonal or interannual exposure patterns. Biosentinel monitoring has been implemented at various locations within the watershed, a subset of which was incorporated into a Fish Mercury Project Ecosystem Restoration Program grant. However, funding to support such a program over the long term is not currently in place. To date, the ongoing biosentinel monitoring program (Slotton et al. 2007) has made these key findings.

- Episodic, aperiodic, and nonroutine flooding (such as seasonal high flows, extremely high tides, and managed marsh flooding) of formerly dry sediments leads to enhanced methylmercury exposure in some areas.
- The general pattern of bioaccumulation was higher fish tissue mercury concentrations in Suisun Marsh, Cosumnes River, and Yolo Bypass but lower tissue concentrations in the central Delta (similar to sport fish results).
- Large differences occurred in fish tissue concentrations from year to year in Suisun Marsh, associated with large variations in the extent of annual flooding.

The current pattern of mercury bioaccumulation in fish in the Delta and Suisun Marsh demonstrates the response to enhanced sources of mercury and methylmercury from water, sediment, and dietary pathways. Larger, piscivorous fish almost uniformly exhibit greater tissue mercury concentrations than human diet consumption guidelines and are linked to sources of influent loading (Central Valley Regional Water Quality Control Board 2008b). Smaller, short-lived fish demonstrate clear spatial patterns of bioaccumulation and the effects of enhanced mercury exposure following the flooding of usually dry areas (Slotton et al. 2007).

Regulatory criteria with respect to mercury are as follows. Applicable water quality criteria for judging the degree of contamination and effects of future changes in concentrations include those following.

- The CTR contains criteria for human health protection of 50 ng/L for freshwater and 51 ng/L for saltwater, which are expressed in the total recoverable form of the metal.
- The national recommended water quality criterion for total mercury is 770 ng/L to protect freshwater aquatic life from chronic exposure and 940 ng/L to protect marine life (U.S. Environmental Protection Agency 2012b).
- The Delta methylmercury TMDL limit of methylmercury in water, protective of fish bioaccumulation, is 0.06 ng/L (Central Valley Regional Water Quality Control Board 2008b).
- The San Francisco Bay mercury TMDL limit of total mercury in water is 25 ng/L (4-day average).

A comparison to Table 8-14 shows that the total mercury criterion (25 ng/L) has been exceeded in the Sacramento River at Freeport, the Calaveras River, and Suisun Bay, but mean concentrations have been below this criterion. In contrast, many of the mean and maximum methylmercury concentrations in water exceed the suggested guidelines for aquatic life (0.06 ng/L) and human health (through fish consumption).

Sediment concentrations can be judged against the Section 303(d) list screening as used by the Central Valley Water Board, based on the consensus screening value of 1.06 mg Hg/kg dry weight (1,060 ng/g) (MacDonald et al. 2000). Note that all total mercury values in Table 8-16 are below this screening value. However, this does not account for the complicated exposure pathways and methylation, which drive uptake and bioaccumulation into the food chain (Figure 8-27) more than does the total mercury concentrations in bulk sediment. Instead, sediment concentrations of mercury and methylmercury can serve as weights of evidence for differences among areas in mercury exposure potential from in-place or resuspended sediments.

The Delta TMDL limit for small, whole-fish mercury content for protection of fish and wildlife is 0.03 mg Hg/kg wet weight (Central Valley Regional Water Quality Control Board 2008b). This is in comparison to 2005–2006 Mississippi silversides whole-body mercury concentrations of 0.03 to 0.06 mg Hg/kg wet weight in the central Delta, 0.17 mg Hg/kg wet weight in the Yolo Bypass, and up to 0.20 mg Hg/kg wet weight at the Cosumnes River site (Slotton et al. 2007). Most of these small fish from the Delta and Suisun Marsh exceeded the recommended Delta TMDL small-fish guideline concentrations for mercury.

USEPA (2012a) has initiated a series of special, focused studies concerned with the control of mercury methylation in marsh and wetland habitats of the Delta, with special emphasis on the mitigation for enhanced methylation as may occur in new restoration wetland environments. As part of their list of water quality challenges and action plan for the Delta, USEPA (2012a) lists the need to "Restore aquatic habitats while managing methylmercury". The plan cites specific ongoing studies by USGS, the Central Valley Water Board, and the California Coastal Conservancy, in conjunction with USEPA, to study treatment technologies that may be used to sequester methylmercury.

Additionally, the Central Valley Basin Plan requires all entities subject to controlling methylmercury in the Delta and Yolo Bypass, including DWR and USBR, to participate in a program to reduce human exposure to mercury through eating fish. Individually or collectively, these entities will submit a mercury exposure reduction program strategy in 2013.

8.1.3.10 Nitrate/Nitrite and Phosphorus

Background and Importance in the Study Area

Nutrients, primarily nitrogen (N) and phosphorus (P), play a complex role in water quality (ammonia-N is discussed in a previous section) and the health of aquatic ecosystems. Phosphorus is generally considered a limiting nutrient in freshwater systems, while nitrogen is generally considered a limiting nutrient in marine systems. A limiting nutrient is one that is in shorter supply for organisms that depend on nutrients for growth relative to the other nutrients, and thus increases or decreases in the limiting nutrient affect primary productivity. In freshwater rivers, phosphorus is usually bound to particles, complexing with elements such as iron. When this freshwater enters estuaries and becomes more saline, the P-iron complex disassociates and the phosphorus is released in a form that can be readily absorbed by algae. Hence there is, in many instances, adequate phosphorus available for algal growth in estuary conditions.

The beneficial uses (Table 8-1) most directly affected by nutrient concentrations include those relevant to aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, noncontact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients. Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients can cause eutrophication, as discussed in the previous sections (DO, ammonia, and turbidity and total suspended solids [TSS]).

There are presently no applicable water quality standards for P. Drinking water standards have been set for nitrate (10 mg/L) and nitrite (1 mg/L) because nitrate and nitrite can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal respiration and causing effects in humans such as blue-baby syndrome. The USEPA in 1998 published the *National Strategy for the Development of Regional Nutrient Criteria* where it identified that, due to the highly variable relationships of nutrient levels to biostimulatory responses across the county, it would not develop national recommended nutrient criteria. Instead, USEPA expects states and tribes to develop water quality standards for nutrients, or nutrient numeric endpoints (NNEs), in their geographic regions. The primary goal of NNEs is to establish nutrient levels that support the health of aquatic systems and also limit excessive growth of macrophytes or phytoplankton, public health threats, and general degradation of aquatic resources. The NNE framework has two components: a) response indicators and regulatory endpoints that specify how to assess water body condition, and b) nutrient-response models that can be used to link response indicators to nutrients and other management controls (e.g., hydrology) on a water body-specific basis.

The State Water Board and USEPA Region 9 office are working to develop NNEs to regulate nutrient levels for inland surface waters in California, excluding inland bays and estuaries. The San Francisco Bay Water Board is working with Southern California Coastal Water Research Project and SFEI staff to develop NNEs for the San Francisco Bay. The Delta Stewardship Council's 2013 Delta Plan recommended that the San Francisco and Central Valley Water Boards prepare study plans for the development of NNEs for the Delta and Suisun Bay. The Delta Plan states that the water boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate, by January 1, 2018. The Central Valley Water Board has embarked on a Nutrient Study Plan, which will be closely coordinated with the San Francisco Bay study effort, to determine whether separate nutrient criteria for the Delta are necessary. The Nutrient Study Plan is considered a necessary prerequisite for any decisions about creating NNEs for the Delta and determining how they would be implemented. The Nutrient Study Plan consists of four topical study areas (i.e., macrophyte, cyanobacteria, nutrient concentrations-forms-ratios, and modeling tools) to assess the fundamental question of whether there is evidence that nutrients contribute to Delta problems associated with macrophytes and algae.

Nutrients in the Delta are derived from a variety of point sources, including municipal discharges, and nonpoint sources, including agricultural and urban runoff. As discussed previously (see the Ammonia section), nutrient concentrations in the Delta are high enough that they are probably not a true limiting factor for algal growth. However, excessively high nutrient concentrations also can be associated with algal blooms and decreased water quality, and it is unclear whether nutrient concentrations are adversely affecting primary productivity, which may be a contributing factor to pelagic organism decline (POD) (see the Ammonia section for more information on POD). Excessive algae growth also can be a concern for municipal beneficial uses as a result of the elevated organic carbon associated with organic biomass. Cyanobacteria are of concern due to toxin formation potential of some species.

Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients such as nitrate can cause eutrophication, in which high algal and bacterial growth and subsequent microbial respiration deplete oxygen, producing anoxic waters and sediments. Waters of the Delta are not considered nutrient-limited; that is, algal growth rates are limited by availability of light, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity (Jassby et al. 2002). However, when waters of the Delta are exported into conveyance canals, algae may no longer be light-limited, and thus increases in nutrient levels in Delta export waters may increase phytoplankton growth in the canals. Algal blooms are problematic in that they create biomass that can obstruct water conveyance facilities and clog filters, and they may also lead to taste and odor problems for municipal supplies (State Water Project Contractors Authority 2007:3-69).

However, regarding the potential for taste and odor concerns, Jones-Lee (2008) summarized a presentation by P. Hutton (Metropolitan Water District), given at the March 25, 2008, California Water and Environmental Modeling Forum (CWEMF) Delta Nutrient Water Quality Modeling Workshop, that stated:

> "there is limited ability to relate nutrient loads or in-channel concentrations to domestic water supply water quality. While there is some ability to model the relationship between the nutrient load to a waterbody and the planktonic algal biomass that develops in the waterbody, it is not possible to adequately model the relationship between nutrient load to a waterbody and the development of benthic and attached algae in that waterbody (Jones-Lee 2008:6)."

This is important in that benthic and attached algae are potentially more important for taste and odor concerns than is planktonic biomass generally (Juttner and Watson 2007:1-2, Taylor et al. 2006).

In addition, changes in ratios of nutrients may affect aquatic life by causing changes in the proportions of algal species, macrophytes and higher species (Glibert et al. 2011). While the impact of nutrient ratios on the proportions of algal species, macrophytes and higher species is unsettled within the scientific community, some analyses demonstrate that the ratio of one nutrient to another, nutrient stoichiometry, may influence primary productivity and community composition. Glibert et al. (2011) analyzed over 30 years of Delta water quality data and conclude that numerous aquatic organism population shifts (i.e., increases in flagellates, cyanobacteria, piscivorous fish, and invasive vegetation and bivalves; and declines in the zooplankton *Eurytomea* sp., delta smelt, and diatoms) were correlated with changes in the quality and quantity of nutrients.

This relationship between nutrient ratios and organism population shifts is not unique to the Delta. Studies in Hong Kong, Tunisia, Germany, Florida, Spain, Korea, Japan and Washington D.C. (Chesapeake Bay), to name a few, have all concluded that nutrient stoichiometry influences phytoplankton community composition (Ruhl and Rybicki 2010; Ibanez et al. 2008; Hodgkiss and Ho 1997; and Glibert et al. 2004). Furthermore, studies by Glibert et al. (2004; 2006), Lomas and Glibert (1999), and Dortch (1990) concluded that diatoms have a preference for nitrate while dinoflagellates and cyanobacteria generally prefer more reduced forms of nitrogen. Hessen (1997) found that a shift from calanoid copepods to *Daphnia* tracked N:P changes in Norwegian lakes. Sterner and Elser (2002) found that zooplankton size, composition and growth rates changed as the N:P ratio changed. Similar changes have been observed in the Delta, though these researchers did not differentiate the form of N between nitrate and ammonium. Glibert et al. (2011) found significant correlations between nutrient ratios and the dominant zooplankton in the Delta over the last 30 years.

The beneficial uses most directly affected by nitrogen and phosphorus concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, non-contact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients.

Existing Conditions in the Study Area

A conceptual model developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2006a) estimated nutrient concentrations across the Central Valley by averaging time series data at many sampling locations. Results indicate that total nitrogen (TN) and total phosphorus (TP) concentrations were typically higher in the San Joaquin River (approximately 1.6 mg/L and 0.16 mg/L, respectively) compared to the Sacramento River (approximately 0.4 mg/L and 0.08 mg/L, respectively). TN was typically in the form of nitrate-N. TP composition varied from high to low concentrations of particulate-phosphorus. TP concentrations showed little inter-seasonal variation for these two rivers, but higher TN concentrations were seen in the Sacramento River during wet months and in the San Joaquin River during dry months (Tetra Tech 2006a).

Overall, TN and TP concentrations in the San Joaquin River and the Delta are relatively high and are at concentrations that would be classified as eutrophic waters. Given the abundance of nutrients, primary productivity in the Delta is fairly low (Jassby et al. 2002), suggesting that factors other than nutrients are limiting, specifically light limitation caused by turbidity levels. The San Joaquin River exhibits symptoms of eutrophic conditions, notably low DO concentrations that impair migration of cold and warm freshwater species (Jassby 2005). However, when waters from the Delta are pumped out in aqueducts for transport, or stored in reservoirs along the way, other limiting factors may disappear and high levels of algal growth may result (Tetra Tech 2006a).

Although effects on water quality usually are related to concentrations of constituents, load estimates may facilitate identification of important sources. Tributary loads were found to vary substantially between wet and dry years, with loads from the Sacramento River exceeding the San Joaquin River loads by nearly a factor of two or greater, especially in dry years (Tetra Tech 2006a). Forest/rangeland loads may dominate the overall nitrogen loads for the Sacramento basin, and agricultural loads may dominate in the overall nitrogen loads to the San Joaquin basin, particularly for wet years. Point source loads from wastewater discharges may contribute nearly half or more of the overall nitrogen and phosphorus loads during dry years in both basins, and possibly during wet years for phosphorus in the San Joaquin basin. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006a).

TN and TP are often subdivided into different chemical species. Filtered water samples consist of dissolved organic nitrogen, nitrate-N (NO_3-N), nitrite-N (NO_2-N), ammonia (NH_3-N), dissolved organic phosphorus, and ortho-phosphorus (ortho-P). Due in part to their immediate biological availability to algae, chemical species typically analyzed by water quality monitoring programs include NH_3-N (see previous section), the combined NO_3/NO_2-N fraction (because of ease of analysis; in oxygenated waters the sample typically is dominated by NO_3-N), and ortho-P.

In the aquatic environment, nitrogen and phosphorus compounds may rapidly cycle between water, organisms, and sediments. Nitrate also is formed in the process of nitrification from ammonia. It is estimated that 75% of the ammonia present in the Sacramento River at Hood is converted to nitrate by the time the water reaches Chipps Island (Central Valley Regional Water Quality Control Board 2010a:4).

Dissolved ortho-phosphate is the form of phosphorus that generally is considered to be available for algal and plant uptake. Total phosphorus may be a better determinant of lake and reservoir productivity because most phosphorus is tied up in plankton and organic particles during periods of high productivity. Therefore, dissolved ortho-phosphate concentrations may be very low in highly productive lakes and reservoirs (Tetra Tech 2006a:2-4). The dynamics and speciation of phosphorus in flowing water bodies such as the Sacramento and San Joaquin Rivers is not as straightforward because they continually receive phosphorus from upstream, groundwater, and runoff. Because of this, the form in which phosphorus is delivered plays a role in determining which form of phosphorus is a better predictor of productivity downstream (Tetra Tech 2006a:2-5). An analysis of source waters to the Delta found that ortho-phosphate may make up from very little to almost all of the TP at a location at any given time (Tetra Tech 2006a:3-25 to 3-26).

Nitrate/Nitrite

Most examined locations in the northern half of the Plan Area, as well as the export area of the Delta, have had low concentrations of NO_3/NO_2-N in recent years (water years 2001–2006), with mean values typically ranging from 0.28 to 0.40 mg/L (Figure 8-29). Concentrations in the southern half of the Delta, however, were typically higher. For example, the CCWD pumping plant #1 had a mean value of 0.46 mg/L, and the Banks pumping plant had a mean value of 0.56 mg/L. The highest mean values were seen at the San Joaquin River near Vernalis (1.34 mg/L) and San Joaquin River at Buckley Cove (1.63 mg/L).

Mean values for the north-of-Delta area ranged from 0.6 mg/L at the Feather River at Oroville to 0.12 mg/L at the Sacramento River at Verona (Table 8-17). South-of-Delta mean values were higher than north-of-Delta stations examined (0.62 to 0.64 mg/L), comparable to the mean at the Banks headworks (0.56 mg/L) (Figure 8-29).

Table 8-17. Nitrate/Nitrite Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Nitrate/Nitrite (mg/L as N)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.03	0.99	0.10	0.08
Sacramento River at Verona	19	0.02	0.34	0.12	0.09
Feather River at Oroville	40	0.01	0.20	0.06	0.04
American River at WTP	39	0.01	0.36	0.07	0.05
California Aqueduct at Check 13	27	0.18	1.50	0.62	0.59
California Aqueduct at Check 29	29	0.19	1.70	0.64	0.50

Source: California Department of Water Resources 2009b.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that NO_3/NO_2-N concentrations at the examined stations generally fluctuate on an annual basis (Figures 8-30a, 8-30b, and 8-31). Higher values have tended to occur during the months of November through March.

Ortho-Phosphorus

Most examined locations have had low concentrations of ortho-P in recent years (water years 2001–2006), with mean values typically ranging from 0.04 to 0.08 mg/L (Figure 8-32). Exceptions include the Barker Slough pumps (mean 0.10 mg/L), the San Joaquin River near Vernalis (mean 0.11 mg/L), and San Joaquin River at Buckley Cove (0.16 mg/L).

Mean values for the north-of-Delta area were all 0.02 mg/L (Table 8-18). South-of-Delta mean values were higher than north-of-Delta and Plan Area stations examined, with mean values of 0.08 to 0.10 mg/L (Banks headworks: 0.07 mg/L) (Figure 8-32).

Table 8-18. Ortho-Phosphorus Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Ortho-Phosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	41	0.01	0.03	0.02	0.02
Sacramento River at Verona	18	0.01	0.05	0.02	0.02
Feather River at Oroville	7	0.01	0.05	0.02	0.01
American River at WTP	8	0.01	0.05	0.02	0.01
California Aqueduct at Check 13	27	0.05	0.15	0.08	0.07
California Aqueduct at Check 29	2	0.04	0.15	0.10	0.10

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that ortho-P concentrations at the examined stations generally fluctuate on an annual basis (Figures 8-33a, 8-33b, and 8-34). However, some stations have seen higher values during the summer and fall months, while other stations have seen higher values during the winter and spring months.

Total Phosphorus

Most examined Delta locations have had low concentrations of TP in recent years (water years 2001–2006), with mean values typically ranging from 0.08 to 0.11 mg/L (Figure 8-35). As seen with ortho-P, exceptions include the Barker Slough pumps (mean 0.20 mg/L), the San Joaquin River near Vernalis (mean 0.19 mg/L), and San Joaquin River at Buckley Cove (0.25 mg/L).

Mean values for the north-of-Delta area were between 0.06 and 0.08 mg/L, with the exception of a lower value of 0.02 mg/L at the American River at WTP (Table 8-19). South-of-Delta mean values were higher than north-of-Delta and Plan Area stations examined, with mean values (0.10 mg/L) near those seen in the Plan Area.

Table 8-19. Total Phosphorus Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Total Phosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.01	0.89	0.06	0.02
Sacramento River at Verona	19	0.02	0.20	0.06	0.04
Feather River at Oroville	36	0.01	1.80	0.08	0.02
American River at WTP	37	0.01	0.10	0.02	0.02
California Aqueduct at Check 13	27	0.06	0.21	0.10	0.10
California Aqueduct at Check 29	29	0.06	0.22	0.10	0.09

Source: California Department of Water Resources 2009b.
Notes: mg/L = milligrams per liter; WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that TP concentrations at the examined stations generally did not fluctuate in a consistent manner on an annual basis (Figures 8-36 and 8-37).

Regulatory criteria with respect to nitrogen and phosphorus are as follows. Regarding Basin Plan narrative objectives, nitrogen and/or phosphorus could be considered biostimulatory substances because they are plant nutrients. There are no numerical water quality criteria for nutrients in the CTR or the Central Valley Water Board Basin Plan. The San Francisco Bay Water Board Basin Plan has objectives of 30 mg/L NO_3 plus NH_4 as nitrogen for agricultural supply—irrigation, and 100 mg/L NO_3/NO_2-N for agricultural supply—livestock watering. The California drinking water MCL is 1 mg/L for NO_2-N and 10 mg/L for NO_3-N because it can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal oxygen transport by the blood and causing effects in humans, particularly infants. Another threshold for nitrate-N is for irrigation water as recommended by Ayers and Westcot (1994), who recommend a value of 5 mg/L NO_3-N for sensitive crops (e.g., sugar beets, grapes, apricot, citrus, avocado, grains).

8.1.3.11 Organic Carbon

Background and Importance in the Study Area

In an aquatic system, organic carbon encompasses a broad range of compounds, all of which fundamentally contain carbon in their structure. Organic carbon may be contributed to the aquatic environment by degraded plant and animal materials, and from anthropogenic sources such as domestic wastewater, urban runoff, and agricultural discharge. TOC represents the summation of both particulate organic carbon (POC) and DOC.

Organic carbon is a critical part of the foodweb and sustains aquatic life in the Delta and Bay. However, organic carbon and bromide, a naturally occurring salt found throughout the Delta, are precursors that contribute to DBP formation risk at drinking water treatment plants that use disinfection processes to treat Delta surface water sources. DBPs in municipal water supplies can be harmful to humans when consumed at low levels over a lifetime, and thus organic carbon concentrations are of primary concern for the municipal water supply beneficial use. Environmental concerns regarding DBPs are related primarily to the consumers (humans, animals) of drinking water containing the DBPs HAAs (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid) and THMs (chloroform, bromodichloromethane, dibromochloromethane, and bromoform). THMs and HAAs are known to cause liver, kidney, and central nervous system problems and an increased risk of cancer (U.S. Environmental Protection Agency 2008c). The risk of DBP formation at drinking water treatment plants that use Delta surface water sources has been, and will continue to be, a central focus of water quality regulations for the Delta and the SWP/CVP Export Service Areas.

DBP-Formation Potential

The primary disinfectants currently used at municipal drinking water treatment plants to remove microbial contaminants consist of chlorine, chloramines, ozone, and ultraviolet (UV) light. Numerous DBPs can be formed by disinfectants reacting with various constituents in the source water, particularly DOC, bromide, and nitrogenous compounds. Chlorine-based disinfectants are a cause in the formation of many DBPs, including the THMs and HAAs. Modern disinfection methods used instead of chlorine to reduce DBP formation include chloramines and chlorine dioxide, ozone, and UV light. Ozone can substantially reduce THM formation, and UV light does not form DBPs; however, ozone can cause formation of bromate if bromide is present in the water (see the *Bromide* section for a detailed discussion of its effects on water quality). UV light disinfection system design must account for potential reduced efficiency associated with elevated turbidity and suspended solids (which can shield bacteria/viruses from radiation) and biological fouling of lamps. Ozone and UV light disinfection processes leave no residual disinfectant in the treated water, so a chlorine disinfectant generally must be added to finished water to provide a residual level of disinfection effect from the drinking water treatment plant through the distribution system to a user's tap. The potential for DBPs to form during drinking water disinfection is a function of source water quality, influenced primarily by DOC concentration and bromide, and a function of treatment operational factors such as disinfectant dose and reaction time, pH, and temperature (Sadiq and Rodriquez 2004). The potential formation of THMs, HAAs, and bromate has been extensively studied, and models are able to predict their formation with reasonable accuracy (Sohn et al. 2004).

Methods to Reduce DBP Formation Risk

Identifying and developing dynamic strategies and options to reduce DBP formation requires analysis of technical feasibility and economic considerations and is one element of the Equivalent Level of Public Health Protection (ELPH) concept of a multibarrier approach to providing drinking water and public health protection. Because organic/inorganic substances act as precursors for DBPs, their removal prior to disinfection is effective in reducing DBP formation potential. Organic matter can be partially removed using conventional coagulation, flocculation, sedimentation, and filtration methods or with more advanced methods (e.g., enhanced coagulation, granular activated carbon [GAC] filtration, and membrane filtration). The control of water treatment operational factors such as pH or disinfection contact time may reduce the formation of DBPs. Ozonation and UV light are the primary existing and alternative disinfection processes to reduce DBP formation that have been considered or implemented by water purveyors that use Delta source waters (Chen et al. 2010). pH reduction can control bromate formation during ozonation; however, the process requires increased ozone dosage and large amounts of acid to lower the pH and base addition to raise pH after ozonation to prevent corrosion in the distribution system (Tetra Tech 2006a).

Our understanding of organic carbon dynamics in the Delta has advanced greatly in recent years, due in part to intensive sampling efforts and research conducted by various institutions (e.g., Chow et al. 2007; Deverel et al. 2007; Drexler et al. 2009a, 2009b; Eckard et al. 2007; Kratzer et al. 2004; Kraus et al. 2008; Municipal Water Quality Investigations 2009; Saleh et al. 2007; Sickman et al.

2007; Spencer et al. 2007; Stepanauskas et al. 2005; U.S. Geological Survey 2003). Sources of organic carbon in the study area include peat soils, upland, agricultural and urban runoff, wetlands, algae production, and municipal wastewater discharges. DOC is present in all the streams and rivers flowing into the Delta, and it is these upstream sources that supply the majority of the organic carbon load to the Delta. It has been estimated that between 50 and 90% of the DOC load entering the Delta arrives from upstream sources (CALFED Bay-Delta Program 2008a:6). There are also sources internal to the Delta, such as agricultural drains and wetlands that, on an annual average basis, provide nearly 25% of the DOC load. These upstream and internal loads, and their related sources, vary by season. Related to particular in-Delta sources, loading of DOC from agricultural drains is typically greatest in the winter, while loading from wetlands is greatest in the spring and summer (Fleck et al. 2007:1, 21; Deverel et al. 2007:18).

In the Delta, THM formation has been found to be strongly correlated to TOC concentrations, but relationships to DOC depend on specific structural characteristics of the organic matter, and research has focused on the sources of DOC as being a critical factor for THM formation potential (Tetra Tech 2006a). A study assessing organic carbon, bromide, and THM formation potential in the California Aqueduct found that TOC concentration was a good predictor of THM formation potential at the Banks pumping plant, the Delta-Mendota Canal (which feeds the Jones pumping plant), and several locations along the California Aqueduct (California Department of Water Resources 2005). The study did not measure DOC. Data collected from August 1998 at various Delta locations (Municipal Water Quality Investigations 2003a:62, Table 4-3) indicated a strong positive relationship between DOC and HAA formation potential ($r^2 = 0.996$). In Delta waters, DOC typically represents 85–90% of TOC (CALFED Bay-Delta Program 2007b:5–22).

The measurement of specific UV light absorbance at a wavelength of 254 nanometers (nm) (SUVA) is a commonly used measure of the potential conversion of DOC compounds into compounds such as THMs; however, SUVA has been found to be a generally poor predictor of THM formation potential in Delta waters (Tetra Tech 2006a). THMs generally are anticipated to be the most abundant DBP formed in treated Delta source water, with HAA formation generally expected to be less than 50% of the DBP production.

Table 8-20 provides a summary of TOC concentrations at several Delta intakes and major tributaries. In general, the highest average concentrations of organic carbon occur in the San Joaquin River and in the Delta, while the lowest average concentrations occur in the Sacramento River.

Concentrations are important to municipal drinking water purveyors because of regulations that require advanced treatment depending on TOC concentrations. Drinking water treatment plants using North Bay Aqueduct water repeatedly have shut down, switched to blending operations with better quality water, or alternative water sources to avoid seasonal precipitation-induced spikes in DOC (Municipal Water Quality Investigations 2003b). DOC in the Delta typically peaks in the winter months, when seasonal river and Delta agricultural drain DOC loading are their greatest (Fleck et al. 2007:1, 21; Deverel et al. 2007:18).

Table 8-20. Total Organic Carbon Concentrations at Delta Intakes and Major Tributaries

Intake	Form	Period	Number of Samples (n)	Median TOC (mg/L)	Maximum TOC (mg/L)
Harvey O. Banks	TOC	1986–2006	252	3.20	16.3
C. W. Jones (Tracy)	TOC	1986–1999	29	3.30	5.0
CCWD Old River	TOC	1994–2006	176	3.00	14.0
CCC (Rock Slough)	TOC	1991–2006	169	3.60	40.0
North Bay Aqueduct (Barker Slough)	TOC	1988–2006	289	4.70	38.0
Sacramento River	TOC	1998–2006	595	1.75	8.6 (19.9)[a]
San Joaquin River at Vernalis	TOC	1986–2006	418	3.30	10.5

Source: CALFED Bay-Delta Program 2007b.

Notes: CCC = Contra Costa Canal; CCWD = Contra Costa Water District; NBA = North Bay Aqueduct; mg/L = milligrams per liter; TOC = total organic carbon.

[a] Maximum reported value is 19.9 mg/L, second highest is 8.6 mg/L; site: Hood/Greene's Landing.

Existing Conditions in the Study Area

The lowest observed mean concentrations of DOC in the Delta during the waters years 2001–2006 ranged from 1.9 to 2.2 mg/L, with the lowest concentrations occurring in the Sacramento River at Hood (Figure 8-38). Higher mean concentrations of DOC occurred in the southern Delta, ranging from 3.3 mg/L at the Banks headworks location to 3.8 mg/L at the San Joaquin River near Vernalis. The highest observed mean DOC concentration occurred at the North Bay Aqueduct pumping plant on Barker Slough (5.7 mg/L). The quality of water in Barker Slough is substantially influenced by local sources located in its immediate upland watershed. These local sources contribute a significant organic carbon load to Barker Slough, particularly during winter months when concentrations of DOC often exceed 10 mg/L (State Water Project Contractors Authority 2007: 3-19, 3-26).

DOC measured in the Sacramento River shows a trend of gradually increasing DOC with distance from Shasta Dam, where median concentrations of about 1 to 1.5 mg/L increase to about 1.5 mg/L to 2 mg/L at Hood (CALFED Bay-Delta Program 2007b:5–58). Major tributaries such as the Feather and American Rivers contain relatively low DOC as well, with median measured concentrations of 1.5 mg/L–2 mg/L. DOC on the lower San Joaquin River is comparatively greater but generally decreases with downstream distance, where median concentrations at Stevinson are nearly 6 mg/L and median concentrations at Vernalis are about 3 mg/L (CALFED Bay-Delta Program 2007b:5–49). This decrease in DOC can be attributed to inputs from tributaries such as the Merced, Tuolumne, and Stanislaus Rivers, with median DOC concentrations of 2 mg/L. Mean values for the north-of-Delta area during water years 2001–2006 ranged from 1.5 mg/L at the Feather River at Oroville to 2.0 mg/L at the Sacramento River at Veterans Bridge (Table 8-21). South-of-Delta mean values were higher than north-of-Delta stations examined (3.2 to 3.4 mg/L), and comparable to the mean at the Banks headworks (3.3 mg/L, Figure 8-38).

Time series data indicate that DOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-39 and Figure 8-40). Higher values have tended to occur during the months of December through March at most locations, particularly the Sacramento River and in-Delta locations, whereas the San Joaquin River concentrations tend to be higher in the summer months as a result of irrigated agricultural drainage (Tetra Tech 2006b).

Table 8-21. Dissolved Organic Carbon Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Dissolved Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	10	0.9	2.5	1.6	1.5
Sacramento River at Veterans Bridge	18	1.2	4.3	2.0	1.6
Feather River at Oroville	28	1.0	2.2	1.5	1.5
American River at WTP	156	1.1	3.7	1.6	1.5
California Aqueduct at Check 13	115	2.1	8.0	3.4	3.1
California Aqueduct at Check 29	86	1.8	7.4	3.2	3.0

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

The lowest observed mean concentrations of TOC in the Delta during the water years 2001–2006 ranged from 2.7 to 3.0 mg/L, occurring at the Sacramento River at Hood and Mallard Island, respectively (Figure 8-41). Higher mean concentrations of TOC occurred in the southern Delta region, ranging from 3.8 mg/L at CCWD pumping plant #1 to 5.1 mg/L at the San Joaquin River near Vernalis. The highest observed mean TOC concentration occurred at the Barker Slough pump (7.8 mg/L).

Mean values for the north-of-Delta area ranged from 1.5 mg/L at the Sacramento River at Keswick to 2.1 mg/L at the Sacramento River at Veterans Bridge (Table 8-22). South-of-Delta mean values were higher than north-of-Delta stations examined (3.9 to 4.2 mg/L) and slightly lower than the mean at the Banks headworks (4.3 mg/L, Figure 8-41).

Time series data indicate that TOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-42 and Figure 8-43). Higher values have tended to occur during the months of December through March.

Table 8-22. Total Organic Carbon Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Total Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	15	1.0	2.6	1.5	1.4
Sacramento River at Veterans Bridge	18	1.2	5.9	2.1	1.6
Feather River at Oroville	28	1.4	3.6	2.0	1.9
American River at WTP	162	1.2	4.8	1.8	1.6
California Aqueduct at Check 13	203	2.1	12.6	4.2	3.5
California Aqueduct at Check 29	158	1.9	14.5	3.9	3.5

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Organic carbon is not a priority pollutant; thus, the CTR has no criteria. There are no state or federal regulatory numerical water quality objectives/criteria for organic carbon or any USEPA-recommended criteria. As a consequence, none of the water bodies in the affected environment are listed as impaired on the state's CWA Section 303(d) list because of elevated organic carbon. However, the Central Valley Water Board recently (July 2013) amended the Drinking Water Policy in the Basin Plan to include new directives to ensure that risks to drinking water quality associated with organic carbon from Delta waters and upstream tributaries do not increase over current levels. The Basin Plan narrative chemical objective (i.e., "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.") was amended to include a new footnote stating, "This includes drinking water chemical constituents of concern, such as organic carbon." The revised policy requires the Central Valley Water Board to consider the necessity for inclusion of monitoring of organic carbon, salinity, and nutrients when renewing waste discharge requirements (WDRs) based on the discharge loading, proximity to drinking water intakes, and trends in ambient conditions for these constituents.

Under USEPA's Disinfectants and Disinfection Byproducts Rule (63 FR 69390), municipal drinking water treatment facilities are required to remove specific percentages of TOC in their source water through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria. USEPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. Where source water TOC is between 4 and 8 mg/L TOC, drinking water utilities may be required to achieve a 45% reduction in TOC. Existing Delta water quality regularly exceeds 2 mg/L TOC, and existing treatment plants already are obligated to remove some amount of TOC. Nevertheless, changes in source water quality at municipal intakes may trigger additional enhanced TOC removal, and associated increased treatment costs.

The CALFED Program established a goal to in addition to USEPA's Disinfectants and Disinfection Byproducts Rule, to achieve TOC of 3 mg/L as a long-term average as applied to municipal drinking water intakes drawing water from the Delta (CALFED Bay-Delta Program 2000). The goal was established based on a study prepared by California Urban Water Agencies (CUWA) recommending Delta source water quality targets sufficient to achieving DBP criteria in treated drinking water and sufficient to allow continued flexibility in treatment technology. Specifically, the goal of the CALFED Drinking Water Program is to:

> achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 µg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies. (CALFED Bay-Delta Program 2000)

The USEPA promulgated the Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule in 1998 and the Stage 2 D/DBP Rule in 2006 under the Safe Drinking Water Act (SDWA) which collectively establish the treatment standards for DBPs, tightened compliance monitoring requirements for DBPs, and strengthened public health protection related to DBP exposure in municipal water distribution systems. The Long Term 2 Enhanced Surface Water Treatment Rule focuses on reducing illness from cryptosporidium and other disease-causing microorganisms in drinking water distribution systems and requires water utilities to balance long-term and short-term health concerns posed by DBPs and pathogens, respectively. The compliance challenge for WWTP operators is to provide adequate disinfection to protect against pathogens without forming DBPs. Development of the Delta Drinking Water Policy by the Central Valley Water Board was identified as a future need during the 1998 and 2001 triennial reviews of the Basin Plan, and by the

CALFED process, with a goal of completing the policy and associated Basin Plan amendments in 2013.

8.1.3.12 Pathogens

Background and Importance in the Study Area

The term *pathogens* refers to viruses, bacteria, and protozoa that pose human health risks. Pathogens of concern include bacteria, such as *Escherichia coli* and *Campylobacter*; viruses such as hepatitis and rotavirus; and protozoans such as *Giardia* and *Cryptosporidium*. Most data that exist regarding pathogens are for coliform bacteria, which are indicators of potential fecal contamination by humans or other warm-blooded animals because of their relative abundance and ease of measuring in water samples.

Sources of pathogens include wild and domestic animals, aquatic species, urban stormwater runoff, discharge from WWTPs, and agricultural point and nonpoint sources such as confined feeding lots and runoff. Pathogens that have animal hosts can be transported from the watershed to source waters from natural lands or grazed lands and cattle operations; aquatic species such as waterfowl also contribute pathogens directly to water bodies. Stormwater runoff from urban or rural areas can contain pathogens carried in waste from domestic pets, birds, or rodents as well as sewage spills. Once in the ambient environment, pathogens often die, although in some instances they can survive and even reproduce in sediments.

The beneficial uses of surface waters in the affected environment that are affected by pathogens are municipal and domestic supply, water contact recreation, shellfish harvesting, and commercial and sport fishing. Of these beneficial uses, municipal and domestic supply and water contact recreation are the receptors most affected by pathogens because direct contact or ingestion affects human health. Infections in humans may arise from pathogens that break through into treated drinking water or from external sources such as food ingestion and ingestion of untreated water during recreation.

Water treatment processes that are focused on the removal of particulates, such as filtration and membranes, are generally effective at removing pathogens. Disinfection of bacteria pathogens can be achieved effectively either through chemical oxidation using chlorine or ozone, or through exposure to UV light. Viruses also can be effectively removed by filtration. The treatment of protozoans is more challenging, as cysts and oocysts of protozoans cannot be fully removed by sand filtration and are resistant to chemical disinfection; however, disinfection using UV light has been found to be effective (Tetra Tech 2007).

Escherichia Coli

Escherichia coli is an anaerobic bacterium that lives in the gastrointestinal tract of warm-blooded animals. The presence of *E. coli* normally is beneficial to the host through the synthesis of vitamins and the suppression of harmful bacteria. However, some strains of *E. coli* are pathogenic. Pathogenic *E. coli* affect humans by generating toxins that can result in diarrhea, inflammation, fever, and bacillary dysentery (U.S. Environmental Protection Agency 2009d). Certain strains of *E. coli* can be severely toxic to some patients, particularly children, causing hemolytic uremic syndrome and leading to destruction of red blood cells and occasional kidney failure (Tetra Tech 2007). The presence of *E. coli* is an indicator of fecal contamination, either by human waste, wastewater, or animal wastes.

Campylobacter

Campylobacter is a bacterium that can be found in natural waters throughout the year. *Campylobacter jejuni* is commonly present in the gastrointestinal tract of cattle, pigs, and poultry and is a leading cause of bacterial gastroenteritis in the United States. *Campylobacter* infection in some rare cases may be followed by Guillain-Barré syndrome, a form of neuromuscular paralysis. Strains of *Campylobacter* have developed resistance to antibiotics, resulting in the difficulties with clinical treatment.

Hepatitis

Hepatitis is a virus that causes liver inflammation and sometimes leads to jaundice. Hepatitis Types A and E are infectious and are transmitted through the fecal-oral route. Hepatitis A is a well-documented waterborne disease and is widespread throughout the world.

Rotavirus

Rotaviruses are the most prevalent viruses that cause diarrhea worldwide. Rotavirus was estimated to contribute to 30 to 50% of severe diarrhea disease in humans (Tetra Tech 2007). The virus can be transmitted through fecal-oral route and through contaminated food and water.

Giardia

Giardia is a parasite found in the intestinal linings of a wide range of animals and their feces, and in contaminated water. *Giardia* can survive a wide range of temperature—from ambient temperature of fresh water to internal temperatures of animals. Among the many species of *Giardia*, *Giardia lamblia* infects humans and causes diarrhea and abdominal pain. *Giardia lamblia* has been found in wastewater and has been related to several outbreaks of waterborne disease around the world (Tetra Tech 2007).

Cryptosporidium

Cryptosporidia are single-celled, intestinal parasites that infect humans and a variety of animals. These parasites can infect epithelial cells of the intestinal wall and are excreted in feces as oocysts. *Cryptosporidium* has a wide range of hosts, including domestic and wild animals. Symptoms of cryptosporidiosis, a disease caused by ingestion of *Cryptosporidium*, include diarrhea, stomach cramps, upset stomach, and slight fever; more serious symptoms can result in weakened immune systems (U.S. Environmental Protection Agency 1999b). Cryptosporidiosis is a major cause of gastrointestinal illness around the world, especially to individuals with compromised immune systems. For these people, the symptoms can be more severe or life-threatening.

Existing Conditions in the Study Area

A conceptual model of pathogens and pathogen indicators was developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2007). The pathogen and indicator data compiled for the model consisted primarily of measurements of total and fecal coliforms and E. coli, some limited data on other species of coliforms, and even more limited data on pathogens such as Cryptosporidium and Giardia. Fecal indicator concentrations are highly variable both temporally and spatially and can vary by orders of magnitude (Tetra Tech 2007). The variable nature of pathogen and indicator concentrations in surface waters, and the rapid die-off of many of these organisms in the ambient environment, makes it very difficult to quantify the importance of different sources on a scale as large as the Central Valley, especially for coliforms that are widely present in water. A single source close to the sampling location can dominate the coliform concentrations observed at a location downstream of several thousand square miles of watershed.

Of the known sources of coliform discharges into the waters of the Central Valley, it was found that wastewater total coliform concentrations for most plants were fairly low (<1,000 most probable number per 100 milliliters [MPN/100 ml]), whereas the highest total coliform concentrations in water (>10,000 MPN/100 ml) were observed near samples influenced by urban areas (Tetra Tech 2007). In fact, the regional water boards limit publicly owned treatment works discharges to <23 MPN/100 ml in NPDES permits, with most plants limited to <2.2 MPN/100 ml. In the San Joaquin River valley, comparably high concentrations of E. coli were observed for waters affected by urban environments and intensive agriculture in the San Joaquin Valley (Tetra Tech 2007). Fecal indicator data showed minimal relationships with flow rates, although most of the high concentrations were observed during the wet months of the years, possibly indicating the contribution of stormwater runoff (Tetra Tech 2007).

Regulatory criteria with respect to pathogens are as follows. The Central Valley Water Board Basin Plan specifies numerical water contact recreation criteria for fecal coliform bacteria not to exceed a geometric mean of 200 organisms/100 ml in any 30-day period (based on a minimum of five samples), nor more than 10% of the total number of samples taken during any 30-day period to exceed 400 organisms/100 ml. The Central Valley Water Board Basin Plan numerical water quality objectives for pathogens are detailed in Appendix 8A, *Water Quality Criteria and Objectives*. The Central Valley Water Board in July 2013 amended the Drinking Water Policy in the Basin Plan to include new directives to ensure that risks to drinking water quality associated with pathogens from Delta source water does not increase over current levels. A new narrative objective was added stating, "Waters shall not contain Cryptosporidium and Giardia in concentrations that adversely affect the public water system component of the MUN beneficial use." The new objective applies to the Delta and tributaries below the first major dams, and allows utilities to request assistance from the state to conduct source evaluations and implement potential control actions if the drinking water utility monitoring at intakes indicates increased risks to treatment from these constituents. The Stockton Deep Water Ship Channel and various sloughs and creeks in the western and eastern Delta are on the state's CWA Section 303(d) list as impaired because of pathogens, with sources identified as recreational and tourism activities [nonboating] and urban runoff/storm sewers (State Water Resources Control Board 2011). A TMDL for the Stockton Urban Waterbodies was approved by EPA on 13 May 2008. TMDLs for other listed water bodies in the affected environment are proposed for completion in 2021(State Water Resources Control Board 2011).

USEPA's surface water treatment rules require that systems using surface water, or groundwater under the direct influence of surface water, to: (1) disinfect water to destroy pathogens and (2) filter water or meet criteria for avoiding filtration to remove pathogens, so that the following contaminants are controlled at the following levels (U.S. Environmental Protection Agency 2009d).

- Viruses: 99.99% removal/inactivation.
- *Giardia lamblia*: 99.9% removal/inactivation.
- *Cryptosporidium*: 99% removal.

Further, USEPA has established an MCL for total coliform requiring no more than 5% positive samples in a month (for water systems that collect fewer than 40 routine samples per month, no more than one sample can be positive per month). Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive total coliform positive samples occur, and one is also positive for *E. coli*/fecal coliforms, the system is deemed as having an acute MCL violation (U.S. Environmental Protection Agency 2009d).

8.1.3.13 Pesticides and Herbicides

Background and Importance in the Study Area

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides typically occur in the form of chemicals or biological agents (e.g., virus or bacterium) and are often formulated for specific pests such as weeds (herbicides), insects (insecticides), and fungi (fungicides), among others. Pesticides may be described in two general categories: current use pesticides and legacy pesticides.

Current use pesticides include carbamates (e.g., carbofuran), organophosphates (e.g., chlorpyrifos, diazinon, methyl parathion, malathion), thiocarbamates (e.g., molinate, thiobencarb), and more recently pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. USEPA has begun to phase out certain uses of organophosphates because of their potential toxicity in humans, which has led to the gradual replacement of organophosphates by pyrethroids (Werner et al. 2008).

Legacy pesticides include primarily organochlorine pesticides like dichlorodiphenyltrichloroethane (DDT) and Group A Pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). These chemicals are highly persistent in the environment and were banned in the 1970s because of their health and environmental effects. Organochlorines are prone to accumulation in sediments.

Pesticides, including pyrethroids, organophosphates, carbamate insecticides, herbicides, and fungicides are used extensively throughout the Central Valley. The critical pathways for pesticides entering the rivers, streams, and the Delta include agricultural and urban stormwater runoff, irrigation return water, drift from aerial or ground-based spraying, and periodic release of agricultural return flows from rice production (Werner and Oram 2008). Agricultural inputs are dominant, but urban inputs are also substantial in areas of high population density (CALFED Bay-Delta Program 2008a) and appear to be a primary source of pyrethroid insecticides entering urban creeks. For example, Weston and Lydy (2010) demonstrated that urban runoff produced pyrethroid concentrations exceeding acutely toxic thresholds. The authors also found that the pyrethroids passed through secondary treatment systems at wastewater treatment facilities, suggesting possible sewer disposal of pyrethroids (e.g., household pesticides).

The timing of pesticide input to Delta waters is related to application rates, when pesticides are applied to farmed land, runoff events, and other transport processes (Kuivila and Jennings 2007). In agricultural applications, for example, diazinon and chlorpyrifos are applied during the dormant season (December through February) and the irrigation season (March through November). Dormant orchards (nuts and fruits) are sprayed to limit pest damage. Application totals for diazinon (1999–2003 average) were 52% dormant season and 48% irrigation season (47,652 pounds total); application totals for chlorpyrifos (1999–2003 average) were 3% dormant season and 97% irrigation season (114,101 pounds total).

Concern about pesticides is primarily associated with nontarget-organism toxic effects; because many pesticides have been developed to target insect pests (e.g., neurotoxins), these pesticides also have the potential to harm other organisms. Pesticides have toxic effects on the nervous systems of terrestrial and aquatic life, and some are toxic to the human nervous system (U.S. Environmental Protection Agency 2008d). Consequently, the beneficial uses (Table 8-1)most directly affected by pesticide concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat);rare, threatened, and endangered species; harvesting activities (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply).

Toxicity of pesticides, like all toxins, is related to the dose an organism receives. For example, a pesticide applied to a rice field in the Sacramento Valley may be diluted many times before it reaches irrigation return canals and the Sacramento River. Aquatic herbicides are applied to control invasive aquatic plants in irrigation canals and in the Delta (CALFED Bay-Delta Program 2008b). A recent assessment of heavily used aquatic herbicides suggests that there is limited short-term and no long-term toxicity directly attributable to their use (Siemering et al. 2008). However, acute toxicity to algae (*Selenastrum capricornutum*) has been found in numerous studies and attributed to the widely used agricultural herbicide diuron (de Vlaming et al. 2005). Ecological effects of pesticide contamination (e.g., fish toxicity) reflect the cumulative influence of pesticides currently in use, those used historically, and the constantly changing new pesticides introduced for agricultural practices (CALFED Bay-Delta Program 2008b).

The Department of Pesticide Regulation, an agency within the California Environmental Protection Agency (Cal/EPA), is charged with administering California's statewide pesticide regulatory program, the largest of its kind in the nation. It administers the CCR Title 6 (Food and Agriculture), which restricts the use of pesticides near water bodies and establishes Pesticide Management Zones and reporting requirements for pesticide use. The Department of Pesticide Regulation also conducts pesticide-monitoring activities. It and other agencies responsible for water quality, such as the State Water Board, promote use of Best Management Practices (BMPs) and other preventive measures to reduce pesticide contamination of water bodies. For example, rice growers are required to hold water on their fields following application of rice pesticides to allow pesticides to degrade, reducing concentrations contained in rice field runoff that enters waterways adjacent to treated fields (Newhart 2002).

The fate and effects of pesticide mixtures in the Delta and the implications of pesticide mixtures for populations of native species are not well understood (Werner and Oram 2008). Monitoring data for pyrethroids in water and sediment are scarce or do not exist, confounding attempts to estimate loads of pyrethroids transported to the Delta from the Central Valley (Werner and Oram 2008; TDC Environmental 2010). Implementation of TMDLs has reduced concentrations of some pesticides in the Delta (e.g., chlorpyrifos, diazinon); incidences of toxicity attributable to organophosphate pesticides have declined substantially compared to observations in the early 1990s (CALFED Bay-Delta Program 2008b). Organophosphates have been shown to be present at elevated concentrations in tributaries and the Delta, and pyrethroids at toxic concentrations have been detected in water bodies draining agricultural areas in the Central Valley, as well as urban creeks in the Delta region (Werner et al. 2008; Weston and Lydy 2010).

Existing Conditions in the Study Area

Limited data and studies are available for characterizing the existing conditions of pesticide concentrations in the study area. These are summarized below.

Monitoring efforts at the north-of-Delta stations since 2001 have resulted in no pesticide detections, while monitoring at the south-of-Delta stations resulted in various detections. The California Aqueduct at Check 13 had detections of chlorpyrifos (3/15/05, 0.02 μg/L), diazinon (3/20/01, 0.01 μg/L), and metolachlor (6/14/05, 0.1 μg/L) and of diuron (eight detections between 3/15/00 and 9/15/09, ranging from 0.27 to 3.2 μg/L) and simazine (13 detections between 3/15/00 and 9/15/09, ranging from 0.02 to 0.14 μg/L). The California Aqueduct at Check 29 had detections of chlorpyrifos (9/20/05, 0.01 μg/L) and dacthal (9/19/07, 0.12 μg/L) and numerous detections of diazinon (four detections between 3/20/01 and 6/22/06, ranging from 0.01 to 0.03 μg/L), diuron (seven detections between 3/14/00 and 9/15/09, ranging from 0.29 to 1.2 μg/L) and metolachlor (detections on 6/15/04 and 6/21/05, 0.01 and 0.01 μg/L).

Monitoring for diazinon suggests that higher concentrations occur in Delta back sloughs and small upland drainages, with lower concentrations occurring in Delta island drains, main rivers, and tributaries (Table 8-23). Monitoring for chlorpyrifos suggests that higher concentrations occur in Delta back sloughs, Delta island drains, and small upland drainages, with lower concentrations occurring in main rivers and tributaries (Table 8-24).

Table 8-23. Diazinon Concentrations, by Water Body Category

Water Body Type	Number of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >160 ng/L[a]
Delta Back Sloughs	352	13	300	1,400	56 (16%)
Delta Island Drains	57	0	17	82	0 (0%)
Delta Rivers and Main Delta Waterways	774	0	97	797	31 (4%)
Major Delta Tributaries	2,056	0	80	1,700	106 (5%)
Small Upland Drainages	146	16	150	2,790	13 (9%)

Source: Central Valley Regional Water Quality Control Board 2006.

Note: ng/L = nanograms per liter.

[a] Acute toxicity water quality objective for diazinon to protect invertebrates.

Table 8-24. Chlorpyrifos Concentrations, by Water Body Category

Water Body Type	Number of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >25 ng/L[a]
Delta Back Sloughs	373	0	68	677	62 (17%)
Delta Island Drains	57	5	46	360	11 (19%)
Delta Rivers and Main Delta Waterways	722	0	0	76	7 (1%)
Major Delta Tributaries	1,887	0	7	700	32 (2%)
Small Upland Drainages	148	0	87	180	35 (24%)

Source: Central Valley Regional Water Quality Control Board 2006.

Note: ng/L = nanograms per liter.

[a] Acute toxicity water quality objective for chlorpyrifos to protect invertebrates.

Pesticide data available for the Banks and Barker Slough pumping plants include the Group A Pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, lindane, endosulfan, and toxaphene), DDT products (p,p'-DDD, p,p'-DDE, and p,p'-DDT), atrazine, chlorpyrifos, diazinon, glyphosate, malathion, molinate, methyl parathion, permethrin, simazine, and thiobencarb. The monitoring program sampled for these analytes approximately 16 times during the water years 2001–2006 for each location. Detections were limited to those presented in Table 8-25. These detections generally occurred during the wet season during wet years. The exception is for molinate, which was detected during the early summer of a dry year (2004).

Table 8-25. Pesticide Concentrations at the Banks and Barker Slough Pumping Plants, Water Years 2001–2006

Pesticide	Harvey O. Banks	Barker Slough
Chlorpyrifos	0.03 μg/L (3/16/05)	–
Diazinon	0.01 μg/L (3/21/01)	0.01 μg/L (3/21/01)
Molinate	0.04 μg/L (6/16/04)	0.04 μg/L (6/15/04)
Simazine	0.12 μg/L (3/21/01)	0.02 μg/L (3/21/01)
	0.02 μg/L (3/20/02)	0.24 μg/L (3/16/05)
	0.11 μg/L (3/16/05)	0.02 μg/L (6/15/05)
	0.05 μg/L (3/15/06)	0.46 μg/L (3/15/06)

Source: Bay Delta and Tributaries Project 2009.

Notes: Data represent water quality samples having values at or greater than the reporting limit.
μg/L = micrograms per liter.

SFEI data for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch, which has very low detection limits, have enabled the detection of many pesticides (Table 8-26). The samples were taken annually between late July and late August, which does not allow examination of wet versus dry season effects. The results suggest that many of the legacy pesticides are still present in the Sacramento River and San Joaquin River outflows during summer conditions, albeit at low concentrations. Chlorpyrifos, diazinon, and DDT median concentrations were higher than the other pesticides; median concentrations for nearly all pesticides were higher in the Sacramento River than in the San Joaquin River.

The Central Valley Water Board and San Francisco Bay Water Board Basin Plans contain narrative objectives for pesticides and toxicity. There are several pesticides with water quality criteria listed under the CTR, the Central Valley Water Board Basin Plan, the San Francisco Bay Water Board Basin Plan, and the California drinking water MCLs (Appendix 8A, *Water Quality Criteria and Objectives*).

Table 8-26. Pesticide Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

		Sacramento River above Point Sacramento (pg/L)					San Joaquin River at Antioch Ship Channel (pg/L)				
Pesticide	Fraction	Samples	Min.	Max.	Mean	Median	Samples	Min.	Max.	Mean	Median
Aldrin	Dissolved	4	1	3	2	2	2	<1	2	1	1
Aldrin	Total	1	4	4	4	4	1	3	3	3	3
Chlorpyrifos	Dissolved	4	300	1,070	719	753	4	76	789	486	541
Chlorpyrifos	Total	4	332	1,070	727	753	4	90	789	490	541
Diazinon	Dissolved	3	511	765	599	520	4	229	1,079	515	375
Diazinon	Total	3	511	765	599	520	4	229	1,079	605	557
Dieldrin	Dissolved	7	56	110	85	82	5	49	81	68	73
Dieldrin	Total	7	60	117	89	84	6	52	87	74	77
Endosulfan I	Dissolved	5	11	57	32	31	2	13	13	13	13
Endosulfan I	Total	2	31	43	37	37	3	13	35	20	13
Endosulfan II	Dissolved	1	34	34	34	34	1	3	3	3	3
Endosulfan II	Total	0					1	3	3	3	3
Endrin	Dissolved	4	2	2	2	2	3	2	2	2	2
Endrin	Total	2	2	2	2	2	2	2	2	2	2
Heptachlor	Dissolved	4	<1	2	1	1	1	1	1	1	1
Heptachlor	Total	2	2	3	2	2	1	1	1	1	1
Heptachlor Epoxide	Dissolved	7	2	24	7	4	5	4	15	6	4
Heptachlor Epoxide	Total	6	2	24	7	4	4	3	15	6	4
Sum of Chlordanes	Dissolved	6	25	106	48	40	5	20	55	37	30
Sum of Chlordanes	Total	5	20	143	66	51	4	27	68	46	45
Sum of DDTs	Dissolved	7	153	227	188	194	5	93	144	124	131
Sum of DDTs	Total	7	266	546	368	366	6	175	257	214	210

Source: San Francisco Estuary Institute 2010.

Notes: Sample size represents water quality samples having values at or greater than the reporting limit. Values for "dissolved" may exceed "total" because of rejected laboratory samples.

DDT = dichlorodiphenyltrichloroethane; Max. = maximum; Min. = minimum; pg/L = picograms per liter.

Regions on the CWA Section 303(d) list for pesticides include the Central Valley Region (chlordane, chlorpyrifos, DDT, diazinon, dieldrin, and Group A pesticides) and the San Francisco Bay Region (chlordane, DDT, dieldrin). The Section 303(d) list of impaired water bodies identifies the entire Delta as impaired by one or more legacy pesticides (State Water Resources Control Board 2011). Chlorpyrifos and diazinon TMDL studies have been completed for Sacramento County urban creeks, the Feather River, the Sacramento River, the San Joaquin River, and the Delta; ongoing TMDL studies are occurring for organochlorine and other pesticides. There are many water bodies served by SWP South-of-Delta exports listed for pesticide impairment (State Water Resources Control Board 2011) including those listed by the Central Coast Water Board, the Los Angeles Water Board, the Santa Ana Water Board, and the San Diego Water Board.

A target list of pesticides has been developed by the Central Valley Water Board (2009d) to assess risk in the study area. The list was based on work by Urban Pollution Prevention Projects for the San Francisco Estuary Project (TDC Environmental 2008). Eight of the 38 pesticides considered highly toxic to aquatic organisms are pyrethroids, and the process has begun to establish water quality criteria for bifenthrin, lambda-cyhalothrin, and cyfluthrin (Central Valley Regional Water Quality Control Board 2010c).

8.1.3.14 Polycyclic Aromatic Hydrocarbons

Background

PAHs are toxic compounds formed primarily as products of incomplete combustion (burning) of substances such as gasoline, coal, oil, wood, garbage, grilled meat, and tobacco (Agency for Toxic Substances and Disease Registry 1995). Some PAHs are manufactured for specific uses such as asphalt, creosote, roofing tar, medicines, dyes, pesticides, and plastics. Mahler et al. (2005) suggest that parking lot sealcoat can be a major source of PAHs to urban water bodies. PAHs in oil products also may exist in a watershed from spills and leaking vehicle fluids, which can then enter the aquatic environment from pavement runoff. PAHs in the environment tend to be found together as complex mixtures rather than single compounds (Oros et al. 2007).

PAHs can lead to red blood cell damage, leading to anemia, suppressed immune system, developmental and reproductive effects, and possibly cancer over a lifetime of exposure (U.S. Environmental Protection Agency 2009e). Wildlife effects (e.g., mammals, birds, invertebrates, plants, amphibians, fish) also have been observed (Eisler 1987). The typical means of exposure to PAHs occurs through inhalation. Other exposure pathways are skin contact of PAH-containing products and ingestion of foods and liquids containing PAH compounds. Consequently, the beneficial uses (Table 8-1) most directly affected by PAHs are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened and endangered species, if the community population level were to be reduced by exposure through the aquatic environment; harvesting activities that depend on aquatic life (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply).

PAHs enter the environment mostly as releases to air from volcanoes, forest fires, residential wood-burning, and exhaust from automobiles and trucks (Agency for Toxic Substances and Disease Registry 1995). They also can enter surface water through discharges from industrial plants and WWTPs and can be released to soils at hazardous waste sites if they escape from storage containers.

PAHs are present in air as vapors or adhere to the surfaces of small solid particles. They can travel long distances before they return to earth through rainfall or particle-settling. Some PAHs evaporate into the atmosphere from surface waters, but most stick to solid particles and settle to the bottoms of rivers or lakes. The solubility of PAHs in water is often very low. PAHs stay adsorbed to soil particles, although some tend to evaporate or contaminate groundwater.

PAHs can break down to longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms.

Benzo[a]pyrene is an example of an environmental PAH that can behave as described above (U.S. Environmental Protection Agency 2009e). Benzo[a]pyrene is expected to bioconcentrate in aquatic organisms that cannot metabolize it. Reported bioconcentration factors include: oysters 3,000; rainbow trout 920; bluegills 2,657; and zooplankton 1,000 to 13,000. The presence of humic acid in solution has been shown to decrease bioconcentration. Organisms that lack a metabolic detoxification enzyme system tend to accumulate these compounds. For example, bioconcentration factors have been found to be very low (<1) for mudsuckers, sculpins, and sand dabs.

There are two major sources of PAHs in drinking water: contamination of raw water (untreated) supplies from natural and human-made sources, and leachate from coal tar and asphalt linings in water storage tanks and distribution lines. PAHs in raw water will tend to adsorb to any particulate matter and be removed by filtration before reaching the drinking water supply. Background levels of PAHs in drinking water range from 4 to 24 ng/L (U.S. Environmental Protection Agency 2009e).

The MCL for benzo[a]pyrene is 0.0002 mg/L. Potential health effects from exposure above the MCL include reproductive difficulties and increased risk of cancer. The public health MCL goal (MCLG) is a concentration of zero (U.S. Environmental Protection Agency 2009e).

Importance in the Study Area

Assessment of how human atmospheric emission sources of PAHs in the study area directly affect the area would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area. Human activities related to PAH land and water emissions may be more easily quantified. Land applications of PAHs in the study area may include unintended releases from hazardous waste containers, while water sources may include industrial wastewaters, municipal sewage, and stormwater runoff.

The Regional Monitoring Program for Water Quality in the San Francisco Estuary has monitored PAHs and other pollutants in San Francisco Bay water, sediments, and bivalves since 1993 at several locations, including the mouths of the Sacramento and San Joaquin Rivers near Antioch.

In an analysis of 1993–2001 data, Ross and Oros (2004) found the distribution of median total PAH concentration by estuary segment was as follows.

- Extreme South Bay (120 ng/L).
- South Bay (49 ng/L).
- North Estuary (29 ng/L).

- Central Bay (12 ng/L).
- Delta (7 ng/L).

These results suggest that the Delta is not a major contributor of PAHs to San Francisco Bay. Using PAH isomer pair ratio analysis, Ross and Oros (2004) showed that PAHs in estuary waters were derived primarily from combustion of fossil fuels/petroleum (possible PAH source contributors include coal, gasoline, kerosene, diesel, No. 2 fuel oil, and crude oil) and biomass (possible contributors include wood and grasses), with lesser amounts of PAH contributed from direct petroleum input.

A modeling exercise of PAHs in San Francisco Bay ranked PAH loading pathways as stormwater runoff (51%), tributary inflow (28%), WWTP effluent (10%), atmospheric deposition (8%), and dredged material disposal (2%) (Greenfield and Davis 2005; Oros et al. 2007). A study of PAH inputs and sources along an urban tributary to the Sacramento River took place in 2004 and 2005 (Kim and Young 2009).

Surface water concentrations varied from 192 to 3,784 ng/L for total PAHs and 18 to 48 ng/L for dissolved PAHs. Precipitation concentrations varied from 77 to 236 ng/L for total PAHs and 15 to 66 ng/L for dissolved PAHs. The authors suggest that indirect deposition (i.e., wash off of atmospheric particles previously deposited to land) of PAHs into surface water is a more likely substantial input pathway for total PAHs than direct dry or wet deposition during the wet season. They also assert that particulate matter carried by stormwater runoff was the major source of PAHs in surface water in the early rainy season.

Existing Conditions in the Study Area

Recent monitoring efforts to assess PAHs are very limited with respect to locations selected. For example, naphthalene had been sampled at three pumping plants (Banks, Barker Slough, CCWD #1) and the San Joaquin River at Vernalis since the late 1990s with no laboratory detections.

The Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel were sampled for 24 different PAH compounds on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of pg/L, which are orders of magnitude more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants. These very low detection limits have enabled the detection of many PAHs examined in the current study, which are presented as the sum of all PAHs in Table 8-27.

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that PAHs are present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for PAHs were comparable between the two locations. No detections were reported in the data examined for the north- and south-of-Delta sampling locations.

Table 8-27. Sum of All Polycyclic Aromatic Hydrocarbons at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PAHs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	2,240	17,444	8,962	9,359
Total	6	9,090	29,205	16,510	15,415
San Joaquin River at Antioch Ship Channel					
Dissolved	5	1,380	16,637	9,881	9,331
Total	6	6,472	21,972	14,117	15,017

Source: San Francisco Estuary Institute 2010.

Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

PAH = polycyclic aromatic hydrocarbon.

Regulatory criteria with respect to PAHs are as follows. There are no listings for PAHs on the Section 303(d) list in the Delta. With regard to Basin Plan narrative objectives, PAHs might be considered toxic at high concentrations. There are no numerical water quality objectives for the Central Valley Water Board or San Francisco Bay Water Board Basin Plans. The CTR criteria for benzo[a]pyrene is 0.0044 µg/L (Human Health: Water and Organisms) and 0.049 µg/L (Human Health: Organisms Only). The California drinking water standard MCL for benzo[a]pyrene is 0.0002 mg/L. Data are inadequate to assess whether the sites examined in this study exceeded the CTR or drinking water standard MCL.

8.1.3.15 Selenium

Background

Selenium is a constituent of concern in the lower San Joaquin River, the Delta, and San Francisco Bay for potential effects on water quality, aquatic and terrestrial resources, and (indirectly) human health. Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the foodchain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive receptors to selenium exposure. Examples of those effects include reduced hatchability of fertile eggs and the development of severe, often lethal, embryo deformities in fish and birds (Department of the Interior 1998; Ohlendorf 2003). Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional nonhabitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

The State Water Board lists the western Delta as having impaired water quality for selenium (under Section 303[d]) (State Water Resources Control Board 2011). The Central Valley Water Board completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA approved this in 2002(Central Valley Regional Water Quality Control Board 2001, 2009c).

The Central Valley Water Board adopted amendments to the Basin Plan for the Sacramento River and San Joaquin River basins to address selenium control in the San Joaquin River basin in May 2010 (Central Valley Regional Water Quality Control Board 2010d), and the State Water Board approved the amendments in October (State Water Resources Control Board 2010b, 2010c). The intent is to modify the compliance time schedule for discharges regulated under WDRs to meet the selenium objective or comply with a prohibition of discharge of agricultural subsurface drainage to Mud Slough (north), a tributary to the San Joaquin River, in Merced County. The proposed amendments and supporting staff report include environmental documentation required under California Public Resources Code 21080.5 and 23 CCR 3775–3782. The environmental documentation is informed by the environmental analysis conducted by Reclamation and the San Luis and Delta Mendota Water Authority, dated December 21, 2009 (Bureau of Reclamation 2009c), which was prepared in compliance with the same legal provisions with regard to the use of the federally owned San Luis Drain. The environmental analysis concluded that, with the agreed-upon mitigation measures, the amendments would have no significant effects on the environment. The Basin Plan amendments are administrative in nature and will not alter any water quality objective, program goal, policy, or other scientific underpinning of the selenium control program for the San Joaquin River.

The San Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

Importance in the Study Area

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. In the Delta watershed, selenium is most enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley (Presser and Piper 1998). Because of erosion of the selenium-enriched sedimentary rock and irrigation practices used in the Central Valley, selenium concentrations in this watershed are high. It is also highly bioaccumulative and is of greatest concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf 2003; State Water Resources Control Board 2011). Bioaccumulation of selenium in diving ducks has led to health advisories for local hunters. Monitoring of selenium in ducks, fish, and invertebrates in the northern part of San Francisco Bay has revealed concentrations that could cause health risks to people and wildlife. Although the entire Bay is listed as impaired by selenium, separate TMDLs for selenium will be developed for the North Bay and South Bay, because the primary selenium loading to the North Bay and the Suisun Bay area is from the Delta and oil refineries in the vicinity of Carquinez Strait while the South Bay is affected by local and watershed sources not associated with the Delta or refineries (Lucas and Stewart 2007; Stewart et al. 2013).

Selenium concentrations in whole-body fish or fish eggs are most useful for evaluating risks to fish, and concentrations in bird eggs are most useful for evaluating risks to birds (Skorupa and Ohlendorf 1991; Department of the Interior 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic [sediment-associated] or water-column invertebrates) also can be used for evaluating risks through dietary exposure, although with less certainty than when using concentrations measured in fish or birds. When data are not available for the target receptors (fish and birds) or for their diets, concentrations can be estimated from selenium in water and suspended particulates. However, such modeling further increases the uncertainties in predictions of risk.

For evaluation of risks to human health, analyses of fish fillets are most common, although the fish should be analyzed in the form that people may eat (for example, for some species or ethnic groups, whole-body analyses may be appropriate) (California Office of Environmental Health Hazard Assessment 2008; see also Chapter 25, *Public Health*).

Existing Conditions in the Study Area

Water Concentrations

Selenium has been monitored most consistently at the mouth of the San Joaquin River at Vernalis (Table 8-28) mainly because agricultural drainage in the San Joaquin Valley is the primary source of selenium to the Delta (Cutter and Cutter 2004; Presser and Luoma 2006; Bureau of Reclamation 2006; Entrix 2008; Tetra Tech 2008).

Selenium also has been monitored frequently at selected locations north and south of the Delta and occasionally at a few locations in the Delta. In addition, a CALFED study (Lucas and Stewart 2007) provided results of several cruises in the study area during 2003–2004, focused primarily on the waterways between Stockton, Rio Vista, and Benicia (Table 8-29 and Figure 8-44).

Total selenium concentrations measured on a weekly basis by the Central Valley Water Board's Surface Water Ambient Monitoring Program at Vernalis (Airport Way monitoring station) show the variation in concentrations by season and year (Figure 8-45).

Before implementation of the Grassland Bypass Project in September 1996, selenium concentrations at Vernalis were commonly twice as high as those shown in Figure 8-45. Implementation of the Grassland Bypass Project has led to a 60% decrease in selenium loads from the Grassland Drainage Area in comparison to preproject conditions (Tetra Tech 2008). Cutter and Cutter (2004) reported a decreased mean concentration of 0.68 μg/L at Vernalis from 1997 to 2000 in comparison to values shown in Table 8-28 and data from a previous study from 1984 to 1988 (1.25 μg/L). More recent data show a mean of 0.54 μg/L (geometric mean of 0.45 μg/L) for the San Joaquin River at Vernalis in 2007–2014 (U.S. Geological Survey 2014). It is likely that the selenium concentration at Vernalis will continue to decrease with continued operation of the Grassland Bypass Project and achievement of Basin Plan objectives in the amendment described above (Central Valley Regional Water Quality Control Board 2010b; State Water Resources Control Board 2010b, 2010c).

Much less sampling has been conducted for selenium analysis in the Sacramento River. The most recent available data for locations in or near the Delta are from Freeport (Table 8-28). A mean concentration of 0.072 μg/L was reported for Freeport in 1984 to 1988 and 1997 to 2000 (years combined, with no apparent difference between the two periods) (Cutter and Cutter 2004), but the detailed data (e.g., min-max values and sample numbers) are not available for comparison to the USGS data shown in the table. Because of the limited data from Freeport, additional values are provided from the Sacramento River at Verona and below Knights Landing (upstream from Sacramento but reflecting quality of water that may enter the Yolo Bypass during flooding). The maximum selenium concentration at those locations was 0.39 μg/L, and the mean concentrations were all less than 0.25 μg/L. Only limited selenium data are available for other major tributaries to the eastern Delta.

1 **Table 8-28. Selenium Concentrations in Surface Water in the Study Area**

Site	No. of Samples	Selenium Concentration (µg/L) Min.	Max.	Mean	Years	Source
Selenium Concentrations North of the Delta						
Sacramento River at Keswick	86	0.061	0.40	0.21	2003–2008	DWR 2010
Sacramento River at Keswick[a]	80	0.090	0.40	0.19	2004–2008	DWR 2010
Feather River at Oroville	31	0.033	0.37	0.19	2003–2008	DWR 2010
Feather River at Oroville[a]	30	0.052	0.28	0.16	2003–2008	DWR 2010
Selenium Concentrations for Inflows to the Delta						
Sacramento River at Verona	24	0.061	0.39	0.21	2003–2009	DWR 2010
Sacramento River at Verona[a]	21	0.15	0.29	0.20	2004–2009	DWR 2010
Sacramento River below Knights Landing	5	0.19	0.30	0.23	2004, 2007, 2008	DWR 2009
Sacramento River at Freeport[a]	88	0.044	0.23	0.09	11/2007–07/2014	USGS 2014
San Joaquin River at Vernalis (Airport Way)[b]	105[c]	0.20	2.3	0.83	1999–2007	Bureau of Reclamation 2009d
San Joaquin River at Vernalis (Airport Way)	201	0.40	2.8	0.98	1999–2002	BDAT 2009
San Joaquin River at Vernalis (Airport Way)[b]	453	0.40	2.8	0.84	1999–2007	SWAMP 2009
San Joaquin River at Vernalis	93	0.070	1.5	0.45	11/2007-08/2014	USGS 2014
Selenium Concentrations within/near the Delta						
North: Cache Slough near Ryer Island Ferry	7	0.05	0.24	0.12	1999–2000	BDAT 2009
South: Old River at Tracy Boulevard	1	0.61	0.61	0.61	2002	BDAT 2009
South: Old/Middle River	6	1.0	1.0	1.0	1999	DWR 2009
South: Old/Middle River[a]	6	1.0	2.0	1.6	1999	DWR 2009
Central-West: Sacramento River near Mallard Island (BG20)	11	0.06	0.45	0.11	2000–2008	SFEI 2010
Central-West: Sacramento River near Mallard Island (BG20)[a]	12	0.03	0.44	0.09	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	11	0.03	0.40	0.11	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)[a]	11	0.03	0.45	0.09	2000–2008	SFEI 2010
Suisun Bay	38	0.02	0.21	0.12	2000–2008	SFEI 2010
Suisun Bay[a]	38	0.02	0.44	0.10	2000–2008	SFEI 2010
Selenium Concentrations for the Delta's Major Outputs						
Banks Pumping Plant[a]	71	1.0	2.0	1.0	2001–2007	MWQI 2003, 2005, 2006, 2008

Sources: Bay Delta and Tributaries Project (BDAT)2009; Department of Water Resources 2009b; Municipal Water Quality Investigations (MWQI) 2003a, 2005, 2006, 2008; Bureau of Reclamation 2009d; San Francisco Estuary Institute 2010; Surface Water Ambient Monitoring Program (SWAMP) 2009; U.S. Geological Survey (USGS) 2014.

Notes: Data include detected concentrations and reporting limits for undetected concentrations. Means are geometric means.
Max. = maximum; µg/L = micrograms per liter; Min. = minimum.

[a] Dissolved selenium concentration.

[b] Not specified whether total or dissolved selenium.

[c] Represents the number of months with an average concentration of selenium, not total samples collected.

1 **Table 8-29. Selenium Concentrations in Surface Water Reported by CALFED Bay-Delta Program**

Site	Number of Samples	Dissolved Selenium (μg/L)			Particulate Selenium (μg/L)			Total Selenium (μg/L)		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
San Joaquin River at Stockton	5[a]	0.52	1.01	0.73	0.005	0.04	0.02	0.55	1.03	0.76
Calaveras River	2[a]	0.55	0.72	0.63	0.005	0.03	0.01	0.56	0.75	0.65
Fourteen Mile Slough	6[a]	0.35	0.94	0.59	0.01	0.03	0.01	0.36	0.95	0.61
McDonald-Empire	5[a]	0.09	0.91	0.17	0.005	0.03	0.01	0.10	0.94	0.18
Mildred Island South	1[a]	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Mildred Island Center	1[a]	0.11	0.11	0.11	0.01	0.01	0.01	0.13	0.13	0.13
Mildred Island North	1[a]	0.09	0.09	0.09	0.01	0.01	0.01	0.10	0.10	0.10
Venice	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.12	0.12	0.12
Franks Tract South	1	0.10	0.10	0.10	0.00	0.00	0.00	0.10	0.10	0.10
Franks Tract East	1	0.10	0.10	0.10	0.002	0.002	0.002	0.10	0.10	0.10
Franks Tract West	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.14	0.14	0.14
Mokelumne River	6[a]	0.09	0.22	0.13	0.01	0.01	0.01	0.10	0.23	0.14
Three Mile Slough	6[a]	0.09	0.13	0.11	0.01	0.02	0.01	0.10	0.15	0.13
Sacramento River at Rio Vista	4	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Antioch	5	0.08	0.17	0.12	0.01	0.03	0.02	0.10	0.19	0.14
Pittsburg East	2	0.07	0.15	0.10	0.01	0.01	0.01	0.08	0.16	0.11
Pittsburg West	2	0.11	0.12	0.11	0.02	0.03	0.02	0.13	0.14	0.14
Suisun East	2	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Suisun Center	2	0.12	0.14	0.13	0.02	0.02	0.02	0.14	0.15	0.15
Suisun West	3	0.13	0.19	0.15	0.01	0.05	0.02	0.15	0.23	0.17
Grizzly Bay East	1	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Grizzly Bay Center	3	0.10	0.17	0.13	0.010	0.017	0.013	0.11	0.18	0.14
Grizzly Bay West	1	0.16	0.16	0.16	0.011	0.011	0.011	0.17	0.17	0.17
Benicia	4	0.11	0.16	0.14	0.01	0.02	0.02	0.13	0.18	0.16

Source: Lucas and Stewart 2007.

Notes: Data collected within 1 mile of sample stations were compiled in the same data location. Means are geometric means. Max. = maximum; μg/L = micrograms per liter; Min. = minimum.

[a] One sample each station was collected during July 2000; all other data are from January 2003 to January 2004.

2

Sporadic sampling has been conducted at a few locations in the Delta (Tables 8-28 and 8-29). The only two locations at which sampling was conducted over several recent years are in the Sacramento and San Joaquin Rivers just upstream of Mallard Island (near the western limit of the Delta). Observed total selenium concentrations at these stations are considered more representative of generalized Delta concentrations than of the individual rivers (Tetra Tech 2008). Total and dissolved selenium concentrations were somewhat lower at those locations during low flow in a dry year (<0.1 μg/L in August 2001) than during high flow (>0.1 μg/L in February 2001) (Tetra Tech 2008). Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum selenium concentration found in the Delta was 2 μg/L at an Old/Middle River location in the south subarea of the Delta. Except for that location, the available data show mean concentrations well below 1 μg/L.

As noted in Table 8-28, inflow originating from the San Joaquin River has selenium concentrations several times higher than those from the Sacramento River, but flows in the San Joaquin River at Vernalis are usually only about 10–15% of the inflow from the Sacramento River at Freeport (Tetra Tech 2008). Therefore, on an annual basis, selenium loads from both rivers to the Delta are large, but selenium processes in the Delta are not well characterized. Besides the processes of settling and mixing, a large portion of the water in the Delta is exported for agricultural and urban uses in other parts of California. The relative contribution of the Sacramento and San Joaquin Rivers to the overall outflow from the Delta to the North Bay changes with tidal cycles and season, as well as operations of SWP/CVP reservoir release and related Delta water supply operations. The contribution from the San Joaquin River potentially can increase during the drier months of September through November (Presser and Luoma 2006; Tetra Tech 2008).

Regulatory criteria with respect to selenium are as follows. A TMDL for selenium in the San Joaquin River was completed by the Central Valley Water Board and approved by USEPA in March 2002. The TMDL is implemented through 1) prohibitions of discharge of agricultural subsurface drainage water adopted in a Basin Plan Amendment for the Control of Subsurface Drainage Discharges (State Water Resources Control Board Resolution 96-078), with an effective date of January, 10 1997; and 2) load allocations in WDRs (Central Valley Regional Water Quality Control Board 2009c). As mentioned above, the Central Valley Water Board adopted a Basin Plan amendment in May 2010 to modify the compliance time schedule for regulated discharges to Mud Slough (north), which is a tributary to the San Joaquin River.

The water quality objective for the lower San Joaquin River at Vernalis is 5 μg/L as a 4-day average for above-normal and wet water-year types, and 5 μg/L as a monthly mean for dry and below normal water-year types (Central Valley Regional Water Quality Control Board 2001, 2007). Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR (San Francisco Bay Regional Water Quality Control Board 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 μg/L (4-day average) and 20 μg/L (1-hour average). By comparison, the available data show that the maximum concentration at Vernalis has not exceeded 3 μg/L since implementation of the Grassland Bypass Project, and the mean is less than 1 μg/L for the period from 1999 through 2014. The CTR criteria for aquatic life protection in saltwater are substantially higher than the freshwater criteria (i.e., chronic = 71 μg/L; acute = 290 μg/L).

Selenium concentrations in water exported from the Delta via Banks pumping plant ranged from 1 to 2 μg/L, with a mean of 1.02 μg/L for 2003–2007. Drinking water standards for selenium are average concentrations of 50 µg/L, both as the MCL—the enforceable standard that defines the highest concentration of a contaminant allowed in drinking water—and the MCLG—a nonenforceable health goal set at a level at which no known or anticipated adverse effect on human health would result, while allowing an adequate margin of safety (U.S. Environmental Protection Agency 2009f). On April 2, 2010, the California Office of Environmental Health Hazard Assessment (OEHHA) proposed establishing a public health goal of 30 µg/L in drinking water, based on data from adverse effects of selenium in a human population, with a 45-day comment period (California Office of Environmental Health Hazard Assessment 2010). Public health goals are developed for use by DPH in establishing primary drinking water standards (state MCLs). All concentrations that have been measured in the Delta, or in tributary streams immediately upgradient of the Delta, as well as those at Banks pumping plant and in the California Aqueduct, are less than 10% of the MCL and the MCLG (Table 8-28 and Table 8-29).

Sediment and Fish Tissue Concentrations

Very little information is available for selenium concentrations in sediment or biota from in the Delta (Table 8-30, Table 8-31, and Table 8-32) that would be useful for evaluating risks for fish, wildlife, or the people consuming them. Selenium concentrations in sediment usually are not closely related to effects on fish or wildlife resources, although screening-level values such as those provided by the U.S. Department of the Interior (DOI) are sometimes used for comparison to background or potential effect levels (U.S. Department of the Interior 1998). Background selenium concentrations in freshwater sediments are typically <1 mg/kg dry weight. Consequently, the concentrations reported for the Sacramento and San Joaquin Rivers near Mallard Island and in Suisun Bay (Table 8-30) are consistent with background levels. They are well below the concentrations associated with effects on fish and bird populations (2.5 mg/kg). Selenium analyses of clams from the Mallard Island locations (Table 8-31) are consistent with other bivalves in the Bay-Delta (Linville et al. 2002; Stewart et al. 2004). Whole-body fish from the San Joaquin River near Manteca had selenium concentrations within the range of background (<1–4 mg/kg, typically <2 mg/kg), although the mean was slightly higher than typical background (Table 8-32). Selenium concentrations in delta smelt from Chipps Island also were consistent with background.

Table 8-30. Selenium Concentrations in Delta and Suisun Bay Sediment

Site	Number of Samples	Selenium Concentration (mg/kg)			Year Collected	Source
		Min.	Max.	Mean		
Central-West: Sacramento River near Mallard Island (BG20)	9	0.031	0.24	0.083	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	9	0.087	0.34	0.21	2000–2008	SFEI 2010
Suisun Bay	69	0.016	0.58	0.17	2000–2008	SFEI 2010

Source: San Francisco Estuary Institute (SFEI) 2010.

Notes: Data include detected concentrations and reporting limits for nondetected concentrations. Means are geometric means.

Max. = maximum; mg/kg = milligrams per kilogram, dry weight concentration; Min. = minimum.

Table 8-31. Selenium Concentrations in Biota in or near the Delta

Site	Number of Samples	Selenium Concentration (mg/kg) Min.	Max.	Mean	Common Name	Year Collected	Source
Central-West: Sacramento River near Mallard Island (BG20)	5	4.0	19	8.1	Clam	1999–2001, 2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	5	4.1	26	9.1	Clam	1999–2001, 2008	SFEI 2010
Chipps Island[a]	41	0.70	2.3	1.5	Delta Smelt	1993, 1994	Bennett et al. 2001
San Joaquin River, Dos Reis State Park and Mossdale Sites[b]	13	1.6	3.4	2.6	Silversides	May–July 1995	Bennett et al. 2001

Sources: Bennett et al. 2001; San Francisco Estuary Institute (SFEI) 2010.

Notes: Means are geometric means.

Max. = maximum; mg/kg = milligrams per kilogram, dry weight concentration; Min. = minimum.

[a] Most of the fish were collected at Chipps Island but included some fish (fewer than 5) from Garcia Bend (near Sacramento).

[b] Near Manteca.

Table 8-32. Selenium Concentrations in Largemouth Bass

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44[a]	9	0.27	0.72	0.46	1.2	2.7	1.9	2000, 2005, 2007
Sacramento River near Rio Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000, 2005, 2007
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000, 2005, 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000, 2005, 2007
Middle River at Bullfrog	6	0.37	0.58	0.47	1.6	2.3	2.0	2005, 2007
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000, 2005, 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000, 2005, 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

Source: Foe 2010.

Notes: Means are geometric means.

Max. = maximum; mg/kg = milligrams per kilogram; Min. = minimum.

[a] Near Clarksburg.

A large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 for mercury analysis. As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (State Water Resources Control Board 2008), archived largemouth bass samples were analyzed for selenium to determine the primary source of the selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). Results of this study are the most relevant biota data from the Delta, and they are summarized in Table 8-32.

There were no differences in selenium concentrations in largemouth bass caught in the Sacramento River between Veterans Bridge and Rio Vista in 2005, and there was no difference in selenium concentration on the San Joaquin River between Fremont Ford (not shown in Table 8-32) and Vernalis (Foe 2010). Also, there was no difference in bass selenium concentrations in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000, 2005, and 2007. The lack of a difference in bioavailable selenium between the two river systems was unexpected because the San Joaquin River is considered a significant source of selenium to the Delta. Selenium concentrations were unexpectedly higher in both river systems in 2007 than in other years; reasons for this difference are related to increased bioaccumulation during low-flow conditions, as discussed in Appendix 8M, *Selenium*.

The Central Valley appeared to be the dominant source of bioavailable selenium to bass in the Delta because tissue concentrations generally decreased seaward (Foe 2010). Selenium concentrations in bass were highest in a dry water-year type (2007), consistent with predictions of the Presser and Luoma (2006) bioaccumulation model.

Selenium concentrations in the bass were compared to criteria recommended for the protection of human health (based on fillets; 2.5 mg/kg, wet weight) and wildlife health (based on whole-body fish; concern thresholds of 4 or 9 mg/kg, dry weight) (Foe 2010). Average concentrations were always less than 4 mg/kg; only 1 of the 69 bass (4.24 mg/kg in a fish from San Joaquin River at Potato Slough in 2007) marginally exceeded that lowest threshold.

Selenium concentrations in the livers of 2 of 86 Sacramento splittail collected from Big Break, Nurse Slough, and Sherman Island exceeded the concentration (>27 mg/kg) (Teh et al. 2004) at which growth, survival, and histopathology effects were observed in long-term laboratory studies of juvenile splittail (Greenfield et al. 2008). Mean selenium concentrations ranged from 11.8 to 16.3 mg/kg in 2001 and from 8.36 to 8.84 mg/kg in 2002, with the highest mean concentrations occurring in fish from Nurse Slough (in Suisun Marsh). Other field and laboratory studies have been conducted with splittail (Deng et al. 2007, 2008) and with white sturgeon (Tashjian and Hung 2006; Tashjian et al. 2006, 2007) and other fish (Linville et al. 2002; Stewart et al. 2004), but no other analytical data for field-collected fish from in the Delta were found.

Species to be considered for linkage of waterborne or foodweb selenium to fish and birds will include those identified by the U.S. Fish and Wildlife Service (USFWS) as being at risk from selenium exposure in the San Francisco estuary, insofar as possible (U.S. Fish and Wildlife Service 2008a). However, species-specific and Delta-specific bioaccumulation and trophic transfer factors for those species are not available, so assessments focus on largemouth bass, which have been sampled at various locations in the Delta.

Current ambient water quality criteria are based on waterborne selenium concentrations, but in 2014 USEPA released draft water quality criteria for the protection of freshwater aquatic life from toxic effects of selenium in 2014, which consist of two fish tissue-based elements and two water column-based elements, as shown in Table 8-32a (U.S. Environmental Protection Agency 2014). The draft criteria emphasize the importance of tissue-based concentrations most closely associated with reproductive effects (in fish eggs or ovaries), but also address the concentrations in whole-body fish or muscle if egg/ovary data are not available and, concentrations in water. Water-column criteria differ for lotic (flowing) and lentic (still-water) aquatic systems.

Table 8-32a. Draft Water Quality Criteria for Selenium

Media Type	Fish Tissue		Water Column[c]	
Criterion Element	Egg/Ovary[a]	Fish Whole-Body or Muscle[b]	Monthly Average Exposure	Intermittent Exposure[d]
Magnitude	15.2 mg/kg	8.1 mg/kg whole body or 11.8 mg/kg muscle (skinless, boneless filet)	1.3 µg/l in lentic aquatic systems 4.8 µg/l in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurement[e]	Instantaneous measurement[e]	30 days	Number of days/month with an elevated concentration

Source: U.S. Environmental Protection Agency 2014

Notes: mg/kg = milligrams per kilogram; µg/l = micrograms per liter.

[a] Overrides any whole-body, muscle, or water column elements when fish egg/vary concentrations are measured.

[b] Overrides any water column element when both fish tissue and water concentrations are measured,

[c] Water column values are based on dissolved total selenium in water.

[d] Where $WQC_{30\text{-day}}$ is the water column monthly element, for either a lentic or lotic system, as appropriate. C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).

[e] Instantaneous measurement. Fish tissue data provide point measurements that reflect integrative accumulation of selenium over time and space in the fish at a given site. Selenium concentrations in fish tissue are expected to change only gradually over time in response to environmental fluctuations.

USEPA's Action Plan for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Estuary (U.S. Environmental Protection Agency 2012a) identifies selenium as one of seven priority items for action. The plan indicates that USEPA will draft new site-specific numeric selenium criteria by December 2012 to protect aquatic and terrestrial species dependent on the aquatic habitats of the Bay Delta Estuary. This planned action continues a long-term effort responding to scientific evidence that the current selenium water quality standards do not adequately protect sensitive species. USFWS and NMFS drafted a Biological Opinion in 2000 that found jeopardy under ESA for the selenium criteria that USEPA proposed in the California Toxics Rule. To avoid a final jeopardy opinion, USEPA agreed to develop site-specific water quality criteria for selenium, beginning in the Bay Delta Estuary. USEPA is using an ecosystem-based model created by the USGS with advice from the USFWS and NMFS. The model reflects the food web in the Bay Delta Estuary, the diet of sensitive species and their use of habitats, and hydrological conditions. (Note: this same modeling approach is used in estimating selenium bioaccumulation in this EIR/EIS.) More stringent selenium water quality criteria may require actions that decrease allowable concentrations of selenium in surface waters of the Bay Delta Estuary and may set allowable levels of selenium in the tissue of fish and wildlife. The new criteria would reduce the chronic (long-term) exposure of sensitive species to selenium.

Following the development of the Bay Delta selenium criteria, USEPA plans to develop site-specific criteria for other parts of California, including the San Joaquin Valley watershed (U.S. Environmental Protection Agency 2012a). USEPA also is engaged in other efforts to minimize selenium discharges to the San Joaquin River and the Bay Delta Estuary, including the Grasslands Bypass Project and the North San Francisco Bay TMDL.

8.1.3.16 Other Trace Metals

Background and Importance in the Study Area

Trace metals such as aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc occur naturally in the environment. Sources of these metals include natural crustal material such as soils, and enriched ore deposits. Because of their industrial and commercial utility, trace metals also can be found in urban and agricultural stormwater runoff, landfill and mine leachate, and industrial and municipal wastewater discharges.

Many trace metals are necessary for healthy biological function, where deficiencies in certain trace metals can result in disease and ailment. At elevated levels, trace metals can be toxic to humans and aquatic life, where the concentration of concern in surface waters is specific to each metal and each receptor (human or aquatic life). Thus, the beneficial uses (Table 8-1) of Delta waters most affected by trace metal concentrations are aquatic life uses (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing), and drinking water supplies (municipal and domestic supply).

Trace metal contamination demonstrates the magnitude of effect that human activities have had on the Delta. Sediment transport to the Bay increased by nearly an order of magnitude during the mid-1800s to early 1900s as a result of hydraulic gold mining operations; these sediments carried high concentrations of metal contaminants, which persist today (Van Geen and Luoma 1999b). The effect of these residual metals in the water column is exacerbated by the decreased river inflows into the Delta in recent years, as well as the continued discharge of contaminants from stormwater runoff and other urban activities.

Hayward et al. (1996), in an evaluation of metals concentrations in the San Joaquin River, found that concentrations of trace metals were uniformly low, with a few isolated exceptions related to specific point sources (e.g., elevated zinc near boat docks in the Stockton Harbor). However, relatively low concentrations in water can have effects on aquatic life. A 2006 study of sediment toxicity in the San Francisco estuary identified toxic hotspots where metals were found to cause sediment toxicity in bivalve embryos (Anderson et al. 2007).

Alpers et al. (2000:2) evaluated metals concentrations in the Sacramento River (Shasta Dam to Delta region) from July 1996 to June 1997, encompassing both low-flow and flood conditions. Their study showed that cadmium, copper, and zinc were transported primarily in dissolved form upstream of major agricultural activities but primarily in colloidal form downstream. Iron and lead were transported primarily in colloidal form at all mainstem Sacramento River sites.

Additional background for aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc is provided below.

Aluminum, Iron, and Manganese

Aluminum, iron, and manganese are common elements in mineral soils. The concentrations of these metals can be substantially elevated above background levels during watershed runoff events that transport high-suspended sediment loads. However, in general, a large majority of the metals are stable within the mineral matrices of the suspended particles and not available to interact chemically with other compounds or otherwise cause adverse water quality effects. When these constituents are in ionic and dissolved forms, they are more readily available to react chemically in the water, and their presence may result in adverse effects to certain water uses. The pH of water is a generally important regulator of the ionic activity of these metals, with lower pH generally resulting in dissociation and creation of ionic forms of the metals with resulting higher dissolved/reactive concentrations in the water. These metals are readily removed via conventional water treatment processes that remove suspended sediment and through chemical ion exchange and adsorption (i.e., chemical coagulation and filtration systems), and surface waters in the affected environment require a minimum of coagulation and filtration to conform to federal SDWA regulations.

Aluminum, iron, and manganese are identified as “non-priority” pollutants by U.S. EPA. Aluminum can cause aquatic toxicity effects to some aquatic biota, and USEPA adopted ambient water quality criteria for dissolved aluminum. There also is a primary MCL for aluminum applicable to drinking water delivered at the tap. All three metals are regulated by secondary MCLs for their potential nuisance effects in domestic potable water supplies (e.g., staining, and taste and odor concerns). The secondary MCLs apply to the total metal concentration in treated potable water. Therefore, ambient concentrations in the total form above the secondary MCLs should not be interpreted as having a direct impact on potable supplies; rather, increased concentrations may indicate the potential for greater levels of treatment required to achieve the same treated concentrations.

Arsenic

Arsenic is a semi-metal element that is tasteless and odorless and highly toxic to humans. Long-term, chronic exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver, and prostate (U.S. Environmental Protection Agency 2009h). Short-term exposure to high doses of arsenic can cause acute symptoms such as skin damage, circulatory system dysfunction, stomach pain, nausea and vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness (U.S. Environmental Protection Agency 2009h).

Sources of arsenic contamination in water supplies include erosion of natural deposits, agricultural runoff, and runoff or wastewater from industrial point sources. Arsenic commonly is found in volcanic rocks and metal oxides, and is commonly associated with sulfide minerals and organic carbon (Saracino-Kirby 2000). Arsenic also is found in certain pesticides, fertilizers, and feed additives used in commercial agricultural operations (Saracino-Kirby 2000; U.S. Environmental Protection Agency 2009h). Approximately 90% of the industrial arsenic used in the United States is used as wood preservative; industry practices such as copper smelting, mining, and coal burning also contribute arsenic to the environment (U.S. Environmental Protection Agency 2009h).

Cadmium

Cadmium can be toxic to humans. Long-term, chronic exposure to cadmium has been linked to blood damage and several forms of cancers; short-term exposure to high concentrations of cadmium may cause nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock, and renal failure (U.S. Environmental Protection Agency 2009i). Some aquatic species (e.g., Chinook salmon, Sacramento sucker, threespine stickleback) tend to bioaccumulate cadmium, while others do not (U.S. Environmental Protection Agency 2009i; Saiki et al. 1995). The toxicity of cadmium to aquatic life varies with the total hardness of the water, exhibiting generally lower toxicity as hardness increases.

Cadmium occurs naturally in zinc, lead, copper, and other ores, which may erode and release cadmium into water bodies, especially in soft, acidic waters (U.S. Environmental Protection Agency 2009i). Cadmium is used in a variety of industrial activities and applications, including metal plating and coating operations, machinery and baking enamels, photography, and nickel-cadmium and solar batteries (U.S. Environmental Protection Agency 2009i). Cadmium can enter water bodies through urban or industrial wastewater, leaching from landfills, and from corrosion of some galvanized plumbing and water mains (Van Geen and Luoma 1999a; U.S. Environmental Protection Agency 2009i).

Regulation of industrial and urban wastewater has led to a steady reduction in metal discharges to water bodies over the past two decades; however, these contaminants persist in sediments. A study of cadmium concentrations in San Francisco Bay revealed that coastal upwelling of cadmium-rich sediment contributes to seasonal peaks in those levels in the Bay. Surface samples collected throughout the Bay confirmed an internal cadmium source unrelated to river discharge. The results of the study suggested that concentrations of cadmium and other metals in the Delta and Bay water column are sensitive to river inflow and may have increased in response to reduced inflows in recent years. (Van Geen and Luoma 1999a.)

Copper

Copper is found primarily in the form of ores with other elements. Copper occurs in both organic and inorganic forms; organic copper is an essential micronutrient for animals, while exposure to high concentrations of inorganic copper can be toxic (Buck et al. 2006; U.S. Environmental Protection Agency 2009j). In humans, short-term exposure to copper can cause nausea and vomiting; long-term exposure can cause liver or kidney damage (U.S. Environmental Protection Agency 2009j).

Sources of copper contamination include natural deposits, industrial and urban wastewater, and urban stormwater runoff (Buck et al. 2006; U.S. Environmental Protection Agency 2009j). Historical copper contamination from industrial development and mining operations persists in sediments in the Delta and Bay (Buck et al. 2006). Dissolved copper tends to bind with organic matter, resulting in a strong correlation between concentrations of dissolved copper and organic carbon (Buck et al. 2006). This binding of copper with organic carbon has reduced concentrations of the toxic form of copper in San Francisco Bay to concentrations that do not pose a threat to aquatic life; without the copper-binding organic matter, it is likely that copper concentrations in the Bay would be toxic to most aquatic microorganisms (Buck et al. 2006).

The most common source of copper contamination in drinking water is corrosion of household copper plumbing materials. This contamination cannot be directly detected or removed with conventional drinking water treatment methods; thus, USEPA requires drinking water suppliers to control the corrosiveness of their water to minimize copper contamination at the tap. (U.S. Environmental Protection Agency 2009j.)

Lead

Lead is a metal found in natural deposits as ores with other elements. Short-term exposure to lead can cause a variety of health effects, including problems with blood chemistry, mental and physical development in babies and young children, and increases in blood pressure in some adults. Long-term exposure to lead has the potential to cause stroke, kidney disease, and cancer. (U.S. Environmental Protection Agency 2009k.)

Sources of lead contamination include natural deposits, mining, and smelting operations (U.S. Environmental Protection Agency 2009k). Lead is sometimes used in household plumbing materials or in water distribution systems. Lead is regulated in drinking water systems via the USEPA's Lead and Copper rule.

Nickel

Recent work has shown that the most substantial sources of nickel are in the South Bay; the next largest source is in the Delta (Yee et al. 2007). Nickel sources in the region originate from natural and human sources such as natural rock erosion, urban runoff, and WWTPs (Yee at al. 2007). Total nickel concentrations from samples in the Delta averaged 3.5 μg/L in the dry season, and 5.1 μg/L in the wet season. Davis et al. (2000) estimated nickel loads were 975,000 kg/year from San Francisco Bay bottom sediments, 410,000 kg/year from the Delta, 49,000 kg/year from Bay tributaries, 4,800 kg/year from effluent, and 580 kg/year from atmospheric deposition.

Silver

Silver is present in San Francisco Bay sediments, which can have toxic effects on biota (Flegal et al. 2007). Most fluxes of silver in the Bay are from past industrial activities and wastewater treatment sources. Delta waters entering the Bay have some of the lowest river silver concentrations reported.

Zinc

Zinc potentially can have toxic effects on biota, although it is an essential element in the diet of these plants and animals. Zinc is used to make tires, so it is generally found at higher concentrations near highways. It is also used in manufacturing processes.

Existing Conditions in the Study Area

In 2000, the Association of California Water Agencies conducted a study to summarize arsenic data from across the state and to assess the effect of USEPA's arsenic standard on California's drinking water programs (Saracino-Kirby 2000). Sampling data collected by USGS in 1990 and 2000, California Department of Health, DWR, Reclamation, and other sources were analyzed. The study found that the statewide average concentration of arsenic in groundwater measured between 1990 and 2000 was 9.8 μg/L, and that 22% of the 4,513 sampling stations recorded arsenic concentrations of 10 μg/L or higher during this time period (Saracino-Kirby 2000) (Table 8-33). The study found no noticeable trend in arsenic concentrations through time (Saracino-Kirby 2000). Thirty percent of the state's groundwater basins were found to have average arsenic concentrations of 10 µg/L or higher at some point between 1990 and 2000 (Saracino-Kirby 2000). The Association of California Water Agencies study also analyzed samples from 188 sampling stations on surface water bodies and found that the statewide average concentration of arsenic in surface water between 1990 and 2000 was 42 µg/L; however, this average was influenced by a small number of data points with very high values—91% of the sampling locations recorded average concentrations less than 10 µg/L during the same time period (Saracino-Kirby 2000).

There was a large monitoring effort from 1988 to 1993 to assess metals in the Delta. Results for San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract are shown in Table 8-33. Analysis of the monitoring results indicated that most metal median values were similar between locations, with zinc median values being the highest of all the metals.

Results from recent monitoring efforts for trace metals at the Banks pumping plant and Barker Slough pumping plant are shown in Table 8-34. Analytes examined in the present effort for the Banks and Barker Slough pumping plants include arsenic, cadmium, copper, lead, nickel, silver, and zinc. The monitoring program sampled for each of these analytes approximately 72 times during the water years 2001 to 2006 at each location. Arsenic, copper, and nickel were detected in almost all sampling events for each location. Median values for these metals were similar at the two locations. Elevated values for these metals occurred primarily between January and March, although the copper maxima occurred during May. There were one detection of lead and three detections of zinc at the Banks pumping plant. There were no detections of cadmium or silver at either station, and no detections of lead or zinc at the Barker Slough pumping plant. Cadmium values matched the MCL of 0.005 mg/L at several locations during the 1988–1993 study, but there were no detections at either the Banks or Barker Slough pumping plants during water years 2001–2006.

SFEI data for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch, which have very low detection limits, are presented in Table 8-35. The samples were taken between late July and late August, which does not allow examination of wet versus dry season results. The samples indicate that all selected metals are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for all metals were comparable for the two locations. For both locations, copper, nickel, and zinc occurred at higher concentrations than the other metals.

Monitoring efforts in the north Delta areas (water years 2001–2006) indicate that mean values for metals at the Feather River at Oroville tended to be lower than those for the Sacramento River sites, with the exception of cadmium and silver (Table 8-36).

Arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc are among the 126 priority pollutants identified by the USEPA. Iron and manganese are identified as non-priority pollutants by USEPA. Federal water quality criteria contained in the CTR, state water quality objectives contained in the Region 2 and Region 5 Water Quality Control Plans, and drinking water MCLs are listed in Appendix 8A, *Water Quality Criteria and Objectives*. Based on water quality criteria and objectives, and typical levels in surface waters, it is generally the case that aluminum, arsenic, iron, and manganese are of primary concern for drinking water, while aluminum, cadmium, chromium, copper, lead, nickel, silver, and zinc are of concern because of potential toxicity to aquatic organisms.

Table 8-33. Median Metal Concentrations for Selected Sites, May 1988–September 1993

Location	Arsenic Dissolved (µg/L)	Arsenic Total (µg/L)	Cadmium Dissolved (µg/L)	Cadmium Total (µg/L)	Copper Dissolved (µg/L)	Copper Total (µg/L)	Lead Dissolved (µg/L)	Lead Total (µg/L)	Zinc Dissolved (µg/L)	Zinc Total (µg/L)
San Joaquin River at Buckley Cove	3	3	5	5	5	5	5	5	6	10
Sacramento River at Green's Landing	2	2	5	5	5	5	5	5	6	8
Sacramento River above Point Sacramento	2	3	5	5	5	7	5	5	5	10
San Joaquin River at Antioch Ship Channel	2	2	5	5	5	6	5	5	5	11
Old River at Rancho Del Rio	2	2	5	5	5	5	5	5	5	8
Suisun Bay at Bulls Head Point near Martinez	2	3	5	5	5	7	5	5	6	15
Franks Tract	2	2	5	5	5	5	5	5	5	7
San Joaquin River at Vernalis	–	–	–	–	–	–	–	–	10	–

Source: Bay Delta and Tributaries Project 2009.

Notes: Units are in micrograms per liter (µg/L). Sample sizes are 10 to 12 (exception: San Joaquin River at Vernalis, with a sample size of 15). Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-34. Metals Concentrations at the Harvey O. Banks and Barker Slough Pumping Plants, Water Years 2001–2006

	Harvey O. Banks Pumping Plant (µg/L)					Barker Slough Pumping Plant (µg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic	71	1	3	2	2	72	1	5	2	2
Cadmium			no detections					no detections		
Copper	71	1	9	2	2	72	1	8	3	2
Lead			one detection: 7 µg/L (11/19/03)					no detections		
Nickel	67	1	2	1	1	72	1	7	2	2
Silver			no detections					no detections		
Zinc			15 µg/L (1/16/02), 5 µg/L (9/17/03), 6 µg/L (10/15/03)					no detections		

Source: Bay Delta and Tributaries Project 2009.

Notes: Metals measured as dissolved. All units are in micrograms per liter (µg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-35. Metals Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

		Sacramento River above Point Sacramento (µg/L)					San Joaquin River at Antioch Ship Channel (µg/L)				
Metal	Fraction	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic	Dissolved	8	0.800	2.270	1.729	1.758	7	1.190	2.310	1.861	1.900
Arsenic	Total	8	0.800	2.420	2.039	2.253	7	1.250	2.500	2.014	2.130
Cadmium	Dissolved	7	0.007	0.016	0.011	0.010	7	0.006	0.015	0.010	0.011
Cadmium	Total	7	0.015	0.032	0.027	0.026	6	0.013	0.033	0.022	0.020
Copper	Dissolved	8	1.253	3.539	1.738	1.468	7	1.410	1.888	1.654	1.606
Copper	Total	8	2.534	4.613	3.418	3.257	7	2.435	4.811	3.028	2.729
Lead	Dissolved	8	0.019	0.091	0.043	0.034	7	0.017	0.196	0.055	0.027
Lead	Total	8	0.427	1.035	0.663	0.580	7	0.263	0.950	0.530	0.445
Nickel	Dissolved	8	0.766	2.641	1.218	1.006	7	0.727	1.470	1.059	0.975
Nickel	Total	8	2.410	6.503	3.970	3.933	7	2.034	6.726	3.157	2.523
Silver	Dissolved	4	0.001	0.002	0.001	0.001	5	0	0.001	0.001	0.001
Silver	Total	7	0.001	0.009	0.004	0.003	5	0.001	0.005	0.002	0.002
Zinc	Dissolved	8	0.160	1.410	0.711	0.595	7	0.253	1.818	0.712	0.510
Zinc	Total	8	2.283	7.022	4.291	3.924	7	1.983	7.055	3.321	2.705

Source: San Francisco Estuary Institute 2010.

Notes: All units in micrograms per liter (µg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

Table 8-36. Metals Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006

	Sacramento River at Keswick (μg/L)					Sacramento River at Verona (μg/L)					Feather River at Oroville (μg/L)					Check 13 (μg/L)					Check 29 (μg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic (d)	25	0.81	1.93	1.27	1.22	8	0.87	1.48	1.18	1.24	22	0.38	0.67	0.52	0.51	69	1	3	2	2	62	1	4	2	2
Arsenic (t)	28	0.84	1.94	1.36	1.30	11	0.92	1.91	1.29	1.20	23	0.47	0.99	0.60	0.56										
Cadmium (d)	8	0.007	0.036	0.021	0.023	1		0.009			1		0.023												
Cadmium (t)	14	0.008	0.095	0.028	0.019	2	0.010	0.020	0.010	0.010	2	0.029	0.033	0.031	0.031										
Copper (d)	25	0.49	3.18	1.40	1.06	8	0.62	4.22	1.55	1.33	22	0.42	1.54	0.70	0.61	69	1.00	5.00	2.00	2.00	81	1.00	4.00	2.00	2.00
Copper (t)	28	0.71	4.30	1.72	1.23	11	0.85	6.54	2.62	1.91	23	0.47	2.82	1.00	0.88										
Lead (d)	13	0.000	0.113	0.026	0.009	6	0.010	0.170	0.080	0.070	9	0.003	0.077	0.019	0.006										
Lead (t)	21	0.008	1.560	0.139	0.040	11	0.090	1.150	0.340	0.130	20	0.001	0.300	0.050	0.015										
Nickel (d)	25	0.49	2.49	1.39	1.32	8	0.58	2.57	1.27	1.13	22	0.40	1.38	0.89	0.88	67	1.00	3.00	1.00	1.00	79	1.00	3.00	1.00	1.00
Nickel (t)	28	0.50	2.73	1.56	1.47	11	0.99	8.94	2.80	1.71	23	0.79	1.93	1.12	1.05										
Silver (d)	1		0.015			1		0.005			2	0.020	0.030	0.030	0.030										
Silver (t)	4	0.003	0.091	0.037	0.027						3	0.020	0.070	0.040	0.040										
Zinc (d)	25	0.31	7.84	2.28	1.91	7	0.16	1.37	0.63	0.30	18	0.04	2.41	0.46	0.27						1		5.00		
Zinc (t)	28	1.02	11.90	3.44	2.38	11	0.53	8.18	2.68	1.16	23	0.13	2.66	0.79	0.48										

Source: Bay Delta and Tributaries Project 2009.

Notes: All units in micrograms per liter (μg/L). Sample size represents water quality samples having values at or greater than the reporting limit.
d = dissolved; t = total.

The CTR contains criteria for protection of freshwater aquatic life, saltwater aquatic life, and human health from consumption of water (drinking water) and organisms (eating fish and shellfish) and consumption of organisms only. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the applicable CTR criteria are the freshwater criteria. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable CTR criteria are the saltwater criteria. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable CTR criteria are the more stringent of the freshwater or saltwater criteria.

CWA Section 303(d) listings in the affected environment include cadmium, copper, and zinc in Lake Shasta and Keswick Reservoir; copper and zinc in the Mokelumne River (eastern portion of Delta waterways);copper in Bear Creek (eastern portion of Delta waterways); and many listings in the Central Coast, Los Angeles, Santa Ana, and San Diego Regions, which include the SWP and CVP Export Service Areas (State Water Resources Control Board 2011).

8.1.3.17 Turbidity and Total Suspended Solids

Background and Importance in the Study Area

TSS is a measure of the particulate matter that is suspended in the water column, consisting of organic materials (e.g., decaying vegetation) and inorganic materials (e.g., inorganic components of soil). Turbidity is a measure of the optical property of water that causes light to be scattered and absorbed rather than transmitted through the water column. The scattering and absorption of light is caused by: (1) water itself; (2) suspended particulate matter (colloidal to coarse dispersions); and (3) dissolved chemicals. Although suspended solids are only one of the factors affecting turbidity, they are often the dominant one. Thus, there is typically, but not always, a good relationship between turbidity and TSS, but this relationship will vary spatially and seasonally.

Sensitive receptors that have the potential to be affected by elevated concentrations of turbidity and TSS are municipal and industrial water supply uses (municipal and domestic supply/industrial service supply), aquatic life beneficial uses (warm freshwater habitat, cold freshwater habitat, migration of aquatic organisms and spawning, reproduction, and/or early development), and estuarine habitat (Table 8-1) because of habitat and other physiological effects. In the Delta, a declining turbidity trend, which has been attributed to a declining sediment supply and invasive submerged aquatic vegetation, is believed to have caused, at least in part, changes in Delta ecology and the decline of delta smelt (Hestir et al. 2013). The filtering of phytoplankton by invasive clams may also be contributing to reduced turbidity in the Delta (Appendix 11A, Section 11A.1.6, *Threats and Stressors*).

Turbidity is a critical measurement for drinking water treatment plants because the constituents suspended in the water affect the filtration systems used to remove disease-causing microorganisms such as viruses, parasites, and some bacteria (e.g., fecal coliforms). Turbidity also can reduce the efficiency of disinfection techniques; disinfectants do not selectively target microbes, but rather react with many constituents within the water matrix (CALFED Bay-Delta Program 2008b).

Monitoring in the San Francisco estuary has used turbidity as a proxy for TSS, which in turn has been correlated to contaminant concentrations such as metals, PAHs, and organochlorine pesticides (Schoellhamer et al. 2007a). One study by Anderson et al. (2007) collected sediment samples between 1994 and 2001 from the mouths of the Sacramento and San Joaquin Rivers; all the samples collected were found to be toxic to mussels. These results suggest that the greatest concern for human health is not TSS itself but rather the contaminants associated with the solids and sediment, which can bioaccumulate up the aquatic food chain and be consumed by humans (e.g., fish, shellfish).

Elevated levels of turbidity and TSS limit light penetration into the water column, altering photosynthesis, primary production, and fish behavior (Schoellhamer et al. 2007b). After runoff events, TSS can settle to cover streambed spawning sites for fish and also alter macroinvertebrate habitat.

A major historical source of TSS in central California was hydraulic mining for precious metals in the late 1800s and early 1900s. The majority of this mining sediment has passed through the Delta system, although mine tailings remain in many watersheds. The construction and operation of dams in the Sacramento and San Joaquin River system have the effect of reducing TSS concentrations downstream because sediments become trapped in the reservoirs. Floodplain management in the form of levees can contribute to instream erosion by confining the flow to the channel and increasing streambed shear stress, but channels for flood management are often lined to protect the channel and minimize erosion (Schoellhamer et al. 2007b).

Given that the dam and levee systems in place are unlikely to be removed, the human activity that most likely affects sediment delivery to the Delta is soil erosion associated with agricultural and urban land uses. These activities are pertinent because they occur downstream from the major dams on the system (Schoellhamer et al. 2007b). Examples include crop production, livestock production, and construction activities. Stormwater runoff and overland flow are the likely mechanisms delivering sediment to streams and larger rivers, although erosion control practices may be implemented to minimize this contribution (Schoellhamer et al. 2007b).

Maintenance of the islands and wetlands in the Delta depends on replenishment of their sediments from upstream sources. At the same time, erosion in Delta channels may expose previously contaminated sediments that can negatively affect biota and drinking water supplies. The Delta also has been identified as a source of toxic sediments to the San Francisco estuary (Anderson et al. 2007).

Some aquatic species, such as the delta smelt, tend to prefer turbid waters (CALFED Bay-Delta Program 2008b). Moreover, relatively turbid Delta waters limit light penetration, thereby limiting the frequency and magnitude of nuisance algal blooms.

TSS concentrations in the Delta range from 10 to 50 mg/L but can exceed 200 mg/L during flood events (Schoellhamer et al. 2007b). The size of suspended particles in Delta waters is typically less than 63 microns. These are silts and clays that tend to remain suspended in the water column (Schoellhamer et al. 2007b). Particulates in the water column play an important role in chemical adsorption and the transport of pollutants. The most sediment is supplied to the Delta during high flows (Wright and Schoellhamer 2005; McKee et al. 2006).

The average annual Delta sediment budget for 1999–2002 as presented by Schoellhamer et al. (2007b) is shown in Figure 8-46. The Sacramento River supplies the greatest input of sediment (66%), followed by the Yolo Bypass (19%), the San Joaquin River (13%), and the eastside tributaries (2%). The largest contributor of sediment to San Francisco Bay from the Delta is the Sacramento River–Yolo Bypass system.

Existing Conditions in the Study Area

The cost-effectiveness and simplicity of sampling for turbidity rather than TSS have resulted in fewer TSS data in recent years. Hence, turbidity data are examined here.

Most examined locations in the Delta have had low mean values of turbidity in recent years (water years 2001–2006), with mean values typically ranging from 8 to 13 nephelometric turbidity units (NTU) (Figure 8-47). The exceptions include the major system inputs (Sacramento River at Hood [18 NTU]) and the San Joaquin River near Vernalis (23 NTU), natural outflows (Sacramento River above Point Sacramento [19 NTU] and San Joaquin River at Antioch Ship Channel [18 NTU]), and the Barker Slough pumps (40 NTU).

Mean values for the north-of-Delta area were typically 5 NTU, with the exception of 19 NTU at the Sacramento River at Verona (Table 8-37). South-of-Delta mean values were typically 6 NTU.

Table 8-37. Turbidity Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Turbidity (NTU)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	17	9	33	5	3
Sacramento River at Verona	18	4	68	19	12
Feather River at Oroville	5	2	10	5	4
American River at WTP	119	1	146	5	2
California Aqueduct at Check 13	69	1	23	6	6
California Aqueduct at Check 29	74	2	21	6	5

Source: California Department of Water Resources 2009b.
Notes: NTU = nephelometric turbidity unit; WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Time series data indicate that turbidity values at the examined stations generally fluctuate on an annual basis (Figures 8-48a, 8-48b, and 8-49), with higher values during the months of December through March.

There are no numeric criteria for TSS. Because TSS and turbidity are not priority pollutants, there are no criteria established for these parameters in the NTR or CTR. The San Francisco Bay Water Board Basin Plan objectives for turbidity are associated with waste dischargers such that turbidity relatable to such discharge shall not increase receiving water by more than 10% in areas where natural turbidity is greater than 50 NTUs. Central Valley Water Board Basin Plan objectives are more restrictive. Applicable objectives are detailed in Appendix 8A, *Water Quality Criteria and Objectives*. None of the water bodies in the affected environment have been listed as impaired on the state's CWA Section 303(d) list due to elevated TSS or turbidity (State Water Resources Control Board 2011).

The current CALFED turbidity goal is 50 NTU for the purposes of reducing turbidity variability (CALFED Bay-Delta Program 2007b).

USEPA's Surface Water Treatment Rules require systems using surface water or groundwater under the direct influence of surface water to implement the appropriate disinfection and/or filtration techniques to minimize turbidity in treated drinking water (U.S. Environmental Protection Agency 2006a).

8.1.3.18 *Microcystis*

Background and Importance in the Study Area

This section provides a brief summary of the background and importance of *Microcystis* in the study area. A detailed discussion of the importance of *Microcystis* in the Delta, its biology, and potential adverse effects due to bloom formation is provided in Section 5.F.7 of BDCP Appendix 5.F, *Biological Stressors on Covered Fish*. The occurrence of *Microcystis aeruginosa* (*Microcystis*), a harmful species of cyanobacteria (also referred to as a blue-green algal species), in the Delta was first observed in 1999 (Lehman et al. 2005). In addition to producing surface scums that interfere with recreation and cause aesthetic problems, it also produces taste and odor compounds and toxic microcystins that are associated with liver cancer in humans and wildlife. Microcystin-LR is the most widely studied congener of the known microcystins, and it has been associated with most incidents of toxicity involving microcystins. *Microcystis* blooms can cause toxicity to phytoplankton, zooplankton, and fish, and also can affect feeding success or food quality for zooplankton and fish. Blooms of *Microcystis* require high levels of nutrients and low turbidity, but also require high water temperature (i.e., above 19°C) and long residence time, because the species is fairly slow growing (Lehman et al. 2008; Lehman et al. 2013). In addition, low vertical mixing associated with high residence time allows *Microcystis* colonies to float to the surface of the water column, where they out compete other species for light.

Existing Conditions in the Study Area

Since its first observance in the Delta in 1999, annual *Microcystis* blooms have occurred at varying levels throughout the Delta, with blooms typically beginning in the central Delta and spreading seaward into saline environments (Lehman et al. 2008; Lehman et al. 2013). Section 5.F.7 of BDCP Appendix 5.F, *Biological Stressors on Covered Fish*, cites numerous studies showing that *Microcystis* blooms produce adverse effects on phytoplankton, zooplankton and fish populations in the Delta. Water temperatures greater than 19°C, low water velocities, and high water clarity are necessary for *Microcystis* levels to reach bloom-forming scale (Paerl 1988; Lehman et al. 2008; Lehman et al. 2013). The water temperature requirement is considered the primary factor that restricts bloom development to the months of June through October (Lehman et al. 2013). Sufficiently high water temperature (i.e., 19°C), low flow and thus sufficiently long residence time, and increased clarity enable bloom formation, which occurs in the San Joaquin River, Old River, and Middle River earlier, and to a greater extent, than other areas of the Delta. Likewise, the Delta's shallow, submerged islands sustain high levels of *Microcystis* during the growing season because the physical drivers of bloom formation are amplified in these areas due to low flushing rates (Lehman et al. 2008). Although elevated pH is tolerated by *Microcystis*, pH is not currently thought to be a primary driver of seasonal and interannual variation in bloom formation (Lehman et al. 2013).

Nutrients have historically been sufficiently high to support *Microcystis* growth in the Delta, yet there is currently little evidence that levels of nitrogen, phosphorus, or their ratio control the seasonal or inter-annual variation in the bloom (Lehman et al. 2005; Lehman et al. 2008; Lehman et al. 2013; Lehman et al. 2015). This is likely because nutrient concentrations in the Delta are above the thresholds that limit *Microcystis* growth (Lehman et al. 2008; Lehman et al. 2013). However, blooms of *Microcystis* in the Delta have been shown to utilize ammonia from the Sacramento River over other forms of nitrogen (Lehman et al. 2015).

Impacts from *Microcystis* blooms outside of the Delta region have only occurred in highly eutrophic lakes, such as Clear Lake, because most reservoirs in the Central Valley region have relatively low nutrient levels. Hydrodynamic conditions of upstream rivers and watersheds are not conducive to *Microcystis* bloom formation. Microcystins have been detected throughout the Delta, but are generally below (Lehman et al. 2005) the World Health Organization (WHO) drinking water advisory level of 1 μg/L for microcystin-LR, the California water guidance level of 0.8 μg/L and the newly published USEPA 10-day Health Advisories (HA) for microcystins. The USEPA HA include a 0.3 μg/L HA for children under 6 and a 1.6 μg/L HA advisory for children over 6 and adults (U.S. Environmental Protection Agency 2015). However, in July and August 2012, microcystin concentrations in the southern area of the Delta exceeded the WHO advisory level, California guidance level and USEPA HA, with a maximum observed concentration of 2.14 μg/L (Spier et al. 2013). Problematic *Microcystis* blooms have not occurred in the Export Service Areas, but microcystins produced in waters of the Delta have been exported from Banks and Jones pumping plants to the SWP and CVP (Archibald Consulting et al. 2012). Levels of microcystin measured in water exported from the Delta were below the 1 μg/L reportable limit (Archibald et al. 2012). However, it is unknown if microcystin concentrations were below the California guidance levels or the USEPA 10-day HA.

8.2 Regulatory Setting

Numerous federal, state and local acts, rules, plans, policies, and programs define the framework for regulating water quality in California. The following discussion focuses on water quality requirements that are applicable to the project alternatives. The federal and state agencies responsible for regulating water quality in the study area are:

- USEPA.
- State Water Board.
- San Francisco Bay Water Board.
- Central Valley Water Board.

USEPA provides guidance and oversight to California in regulating water quality, as it does for other states and for tribes. As in other states across the country, USEPA delegates various authorities for establishing water standards and regulating controllable factors affecting water quality to the state. In California, this authority is delegated to the State Water Board. The State Water Board, in turn, delegates authority to its nine regional water boards to implement the state's water quality management responsibilities in the nine geographic regions. Although the state generally takes the lead on developing and adopting water quality standards for California, USEPA must approve new or modified standards. Thus, USEPA, the State Water Board, and the two Regional Water Boards cited above have worked together to establish existing water quality standards for the study area. Water quality standards have three components: (1) the beneficial uses of the water to be protected; (2) the water quality criteria (referred to as *objectives* in California) that must be met to protect the beneficial uses; and (3) an antidegradation policy to protect and maintain water quality when it is better than the criteria/objectives. Additionally, CDFW, USFWS, NMFS and the Federal Energy

Regulatory Commission impose water quality standards such as DO and temperature in the study area.

8.2.1 Federal Plans, Policies, and Regulations

8.2.1.1 Clean Water Act

The federal CWA (33 United States Code Section 1251 et seq.) places primary reliance for developing water quality standards on the states (e.g., water quality objectives). The CWA established the basic structure for regulating point and nonpoint discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. The CWA authorizes USEPA to delegate many permitting, administrative, and enforcement aspects of the law to state governments. However, USEPA still retains oversight responsibilities. In California, such responsibility has been delegated to the state, which administers the CWA through the Porter-Cologne Water Quality Control Act (Porter-Cologne Act)(California Water Code Section 13000 et seq.). Under the Porter-Cologne Act, the State Water Board oversees nine Regional Water Boards that regulate the quality of waters within their regions.

Section 303(d)

If the CWA's permit program fails to clean up a river or river segment, states are required to identify such waters and list them in order of priority. Thus, under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water quality–limited segments of rivers and other water bodies under their jurisdiction. Listed waters are those that do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that action plans, or TMDLs, be developed to monitor and improve water quality. *TMDL* is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs can lead to more stringent NPDES permits (CWA Section 402).

Section 401

Under CWA Section 401, applicants for a federal permit or license to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval [such as issuance of a CWA Section 404 permit]) must comply with CWA Section 401. In California, the authority to grant water quality certification has been delegated to the State Water Board, and applications for water quality certification are typically processed by the Regional Water Board with local jurisdiction. Water quality certification requires evaluation of potential effects in light of water quality standards and CWA Section 404 criteria governing discharge of dredged and fill materials into waters of the United States. For the proposed project, water quality certifications may be obtained from either the State

Water Board (e.g., for large scale authorizations for project actions such as a Section 404 Regional General Permit), or the Central Valley Water Board or San Francisco Bay Water Board for individual facility construction elements of the proposed project in each agency's jurisdictional area.

Section 402

Under CWA Section 402, point- and nonpoint-source discharges to surface waters are regulated through the NPDES program. In California, the State Water Board oversees the NPDES program, which is administered by the Regional Water Boards. The NPDES program provides both general permits (those that cover a number of similar or related activities) and individual permits.

The NPDES Wastewater Program has responsibility for regulating wastewater discharges to surface waters. Primary program activities include: 1) issuing NPDES permits (new and renewals); 2) monitoring discharger compliance with permit requirements (review of discharger self-monitoring reports and compliance inspections); 3) taking enforcement action as appropriate; 4) investigating spills and illegal discharges; and 5) handling petitions and litigation.

The NPDES Stormwater Program regulates municipal (Municipal Separate Storm Sewer Systems), construction, industrial, and California Department of Transportation stormwater discharges. BMPs to control sediment erosion typically are used as part of this program. In general, the stormwater program differs from many other programs in that it uses general permits adopted by the State Water Board. Dischargers that desire coverage under these permits must submit a Notice of Intent to the State Water Board indicating the intent to be covered under the general permit and comply with its requirements. Exceptions to this process include Phase I Municipalities and the California Department of Transportation. Beginning in March 2003, all construction activities with 1 acre of soil disturbance or greater are required to obtain coverage under the General Construction Permit.

Section 404

Under CWA Section 404, a program was established to regulate the discharge of dredged and fill material into waters of the United States, including some wetlands. USACE is authorized to issue Section 404 permits. Activities in waters of the United States that are regulated under this program include fill for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and conversion of wetlands to uplands for farming and forestry. The basic premise of the program is that no discharge of dredged or fill material may be permitted if: 1) a practicable alternative exists that is less damaging to the aquatic environment, or 2) the nation's waters would be significantly degraded; and that remaining unavoidable impacts will be addressed with compensatory mitigation. In 2008, USEPA and USACE jointly promulgated regulations revising and clarifying requirements regarding compensatory mitigation. According to regulations jointly promulgated in 2008 by USEPA and USACE, compensatory mitigation means the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of wetlands, streams and other aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Construction for the water conveyance facilities and several other conservation measures associated with the proposed project would be subject to regulation under Sections 401, 402, and 404 of the CWA.

8.2.1.2 Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the USACE for the construction of any structure in or over navigable waters of the United States, the excavation/dredging or deposition of material in these waters, or any obstruction or alteration in navigable water.

Construction for the water conveyance facilities and several other conservation measures associated with the proposed project would be subject to regulation under Section 10 of the Rivers and Harbors Act.

8.2.1.3 Federal Antidegradation Policy

The federal antidegradation policy is designed to provide the level of water quality necessary to protect existing uses and provide protection for higher quality and national water resources. The federal policy directs states to adopt a statewide policy that includes the following primary provisions (40 Code of Federal Regulations [CFR] 131.12).

Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

1. Where the quality of waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the state finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.
2. Where high quality waters constitute an outstanding national resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

8.2.1.4 National Toxics Rule

In 1992, pursuant to the CWA, USEPA promulgated the NTR to establish water quality criteria for 12 states and two territories, including California, that had not complied fully with Section 303(c)(2)(B) of the CWA (57 FR 60848). As described in the preamble to the final NTR, when a state adopts and USEPA approves water quality criteria that meet the requirements of Section 303(c)(2)(B) of the CWA, USEPA will issue a rule amending the NTR to withdraw the federal criteria for that state. If the state's criteria are no less stringent than the promulgated federal criteria, USEPA will withdraw its criteria without notice and comment rules because additional comment on the criteria is unnecessary (65 FR 19659). However, if a state adopts criteria that are less stringent than the federally promulgated criteria, but in USEPA's judgment fully meet the requirements of the CWA, USEPA will provide an opportunity for public comment before withdrawing the federally promulgated criteria (57 FR 60860, December 22, 1992). Amendments to the NTR occurred in May 1995 and November 1999. The CTR (described in Section 8.2.2.9) subsequently was promulgated in 2000 and carried forward the established criteria of the NTR, thereby providing a single regulation containing California's adopted and applicable water quality criteria for priority pollutants.

8.2.1.5 Safe Drinking Water Act

The SDWA was established to protect the public health and quality of drinking water in the United States, whether from aboveground or underground sources. The SDWA directed USEPA to set national standards for drinking water quality. It required USEPA to set MCLs for a wide variety of potential drinking water pollutants (Appendix 8A, *Water Quality Criteria and Objectives*). The owners and operators of public water systems are required to comply with primary (health-related) MCLs and encouraged to comply with secondary (nuisance- or aesthetics-related) MCLs.

SDWA drinking water standards apply to treated water as it is served to consumers. All surface waters require some form of treatment in order to meet drinking water standards. The degree of treatment needed depends on the quality of the raw water. The highest quality raw surface waters need only to be disinfected before being served to consumers. More typically, raw water is treated in a conventional WWTP that includes sedimentation, filtration, and disinfection processes. Municipal water suppliers prefer raw water sources of high quality because their use minimizes risk to public health and because their use minimizes the cost and complexity of treatment to meet SDWA drinking water standards.

Some constituents of Delta water are of particular concern to municipal contractors because they are either not removed, only partially removed, or are transformed by the treatment process into hazardous substances by community-used water treatment processes. Constituents of concern include TDS, chloride, bromide, and organic compounds. These substances can be removed from raw water by advanced water treatment processes, but to do so substantially increases the cost borne by municipalities.

8.2.1.6 Surface Water Treatment Rule

The federal Surface Water Treatment Rule is implemented by the California Surface Water Treatment Rule, which satisfies three specific requirements of the SDWA by: 1) establishing criteria for determining when filtration is required for surface waters; 2) defining minimum levels of disinfection for surface waters; and 3) addressing *Cryptosporidium* spp., *Giardia lamblia*, *Legionella* spp., *E. coli*, viruses, turbidity, and heterotrophic plate count by setting a treatment technique. A treatment technique is set in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. The Surface Water Treatment Rule applies to all drinking water supply activities in California; its implementation is overseen by DPH.

8.2.1.7 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rule

The Stage 1 D/DBP Rule established maximum residual disinfectant level goals and maximum residual disinfectant levels for chlorine, chloramines, and chlorine dioxide. It also set MCLGs and MCLs for THMs, five HAAs, chlorite, and bromate. The primary purpose of the Long-Term 1 Enhanced Surface Water Treatment Rule is to improve microbial control, especially of *Cryptosporidium*.

Water systems that use surface water and conventional filtration treatment are required to remove specified percentages of organic materials, measured as TOC, which may react with disinfectants to form DBPs. Removal is to be achieved through a treatment technique (e.g., enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

USEPA adopted the Stage 2 Microbial and Disinfection Byproducts Rules in January 2006. The Rules include both the Stage 2 D/DBP Rule and Long-Term 1, and Long-Term 2 Enhanced Surface Water Treatment Rule. These rules include revised and new requirements, such as water systems having to meet DBP MCLs at each monitoring site in the distribution system, rather than averaging multiple sites. The rules also contain a risk-targeting approach to better identify monitoring sites where customers are exposed to high levels of DBPs. The rules include new requirements for treatment efficacy and *Cryptosporidium* inactivation/removal, as well as new standards for DBPs, disinfectants, and potential contaminants.

The overall goal of this group of regulations is to balance the risks from microbial pathogens with those from carcinogenic DBPs. All domestic water suppliers must follow the requirements of these rules, which are overseen by DPH.

8.2.2 State Plans, Policies, and Regulations

8.2.2.1 Porter-Cologne Water Quality Control Act of 1969

Under the Porter-Cologne Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses. The act requires the Regional Water Boards to formulate and adopt WQCPs, commonly called *Basin Plans*, that designate the beneficial uses of the water to be protected, and establish water quality objectives and a program to meet the objectives. Water quality objectives means the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance in a specific area. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

A change in water quality is allowed only if the change is consistent with the maximum beneficial use of the waters of the state, would not unreasonably affect the present or anticipated beneficial uses, and would not result in water quality lower than that specified in applicable Basin Plans (Central Valley Regional Water Quality Control Board 2009a). The proposed project is subject to the Porter-Cologne Act.

8.2.2.2 State Water Resources Control Board Water Rights Decisions, Water Quality Control Plans, and Water Quality Objectives

The preparation and adoption of Basin Plans is required by the California Water Code (Section 13240) and supported by the CWA. Section 303 of the CWA requires states to adopt water quality standards that “consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses.” According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives. Beneficial uses are defined in Water Code Section 13050(f) as including domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and the preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Because beneficial uses, together with their corresponding water quality objectives, can be defined per federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the state and federal requirements for water quality control. One substantial difference between the state and federal programs is that California's Basin Plans establish standards for groundwater in addition to surface water. Adoption or revision of surface water standards is subject to the approval of USEPA.

The State Water Board is responsible for protecting, where feasible, the state's public trust resources, including fisheries, and has the authority under Article X, Section 2, of the California Constitution and Water Code Section 100 to prevent the waste or unreasonable use, unreasonable method of use, or the unreasonable method of diversion of all waters of the state.

The State Water Board Water Rights Division has primary regulatory authority over water supplies and issues permits for water rights—specifying amounts, conditions, and construction timetables—for diversion and storage facilities. Water rights decisions implement the objectives adopted in the Delta WQCP and reflect water availability, recognize prior water rights and flows needed to preserve instream uses (such as water quality and fish habitat), and whether the diversion of water is in the public interest.

Basin Plans adopted by Regional Water Boards are implemented primarily through the NPDES permitting system and issuance of WDRs to regulate waste discharges so water quality objectives are met. Basin Plans provide the technical basis for determining WDRs and authorize the Regional Water Boards to take regulatory enforcement actions if deemed necessary.

8.2.2.3 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

The current WQCP in effect in the Delta is the *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) (State Water Resources Control Board 2006). The Bay-Delta WQCP identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives.

The 2006 Bay-Delta WQCP adoption did not involve substantial changes to the prior 1995 Bay-Delta WQCP. The 1995 Bay-Delta WQCP was developed as a result of the December 15, 1994, Bay Delta Accord, which committed SWP and CVP to new Delta habitat objectives. In 1999, the State Water Board, through a water rights decision D-1641, assigned responsibilities to entities holding certain water rights to help meet the objectives of the WQCP. One key feature of the 1995 Bay-Delta WQCP is the estuarine habitat objectives (X2) for Suisun Bay and the western Delta. The X2 standard refers to the position at which 2 ppt salinity occurs in the Delta estuary and is designed to improve shallow-water fish habitat in the spring of each year. The X2 standard requires specific daily or 14-day salinity, or 3-day averaged outflow requirements, to be met for a certain number of days each month from February through June. D-1641 also implemented the Vernalis salinity objective and directed the Regional Board to adopt salinity objectives and an implementation program for the lower San Joaquin River. (See 8.2.2.12 below.)

Other elements of the Bay-Delta WQCP include export-to-inflow ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, minimum Delta outflow requirements, and San Joaquin River salinity and flow standards.

8.2.2.4 Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins

The Basin Plan for the Central Valley Water Board covers an area including the entire Sacramento and San Joaquin River basins, involving an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in this Basin Plan extends some 400 miles, from the California-Oregon border southward to the headwaters of the San Joaquin River. The proposed project will be required to meet the water quality objectives in the Basin Plan for the Sacramento and San Joaquin River basins, which was designed to protect the beneficial uses of the Sacramento and San Joaquin Rivers and their tributaries and was last amended in 2009 (Central Valley Regional Water Quality Control Board 2009a).

8.2.2.5 San Francisco Bay Basin Water Quality Control Plan (Basin Plan)

This Basin Plan covers 1,100 square miles of the 1,600–square mile San Francisco Bay estuary and includes coastal portions of Marin and San Mateo Counties, from Tomales Bay in the north to Pescadero and Butano Creeks in the south. The Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks natural topographic separation between the northern and southern coastal mountain ranges. The region's waterways, wetlands, and bays form the centerpiece of the fourth-largest metropolitan region in the United States, and the region includes all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

8.2.2.6 State Water Board Resolution No. 68-16—Statement of Policy with Respect to Maintaining High Quality Waters in California (State Antidegradation Policy)

The goal of State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality Waters in California) is to maintain high quality waters where they exist in the state. State Board Resolution No. 68-16 states, in part:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies.

2. Any activity that produces or may produce a waste or increased volume or concentration of waste and that discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements that will result in the best practicable treatment or control of the discharge necessary to ensure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the state will be maintained.

The State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy, which is applicable if a discharge that began after November 28, 1975, will lower existing surface water quality.

8.2.2.7 State Water Resources Control Board Sources of Drinking Water Policy (Resolution No. 88-63)

The Sources of Drinking Water Policy established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. Under the policy, unless otherwise designated, Regional Water Boards must consider all surface water and groundwater as suitable, or potentially suitable, for municipal or domestic water supply. The policy defines the following three categories of waters potentially eligible for an exception from the designation and protection of a water source for municipal/domestic supply.

- Water bodies with high salinity (defined as TDS >3,000 mg/L), that either have naturally high contaminant levels that cannot reasonably be treated using either BMPs or best economically achievable treatment practices, or produce too low yield (<200 gallons per day).
- Waters designed or modified to treat wastewaters (domestic or industrial wastewater, process water, stormwater, mining discharges, or agricultural drainage), provided that such systems are monitored to ensure compliance with all relevant water quality objectives.
- Groundwater aquifers regulated as geothermal energy–producing sources or aquifers that have been exempted administratively by federal regulations for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy.

8.2.2.8 Policy for Implementation and Enforcement of the Nonpoint-Source Pollution Control Program (Water Code Section 13369[a][2][B])

Agricultural return flows include flows from tile drains and irrigation and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediments, and nutrients, from cultivated fields into surface water. Many surface water bodies are impaired because of pollutants from agricultural sources. Groundwater bodies in California's agricultural areas also have suffered pesticide, nitrate, and salt contamination.

Historically, most Regional Water Boards regulated these discharges under waivers, as authorized by Water Code Section 13269, and other administrative tools were seldom used. Section 13269 allows the Regional Water Boards to waive the requirement for WDRs if it is in the public interest. Although waivers were always conditional, the historical waivers had few conditions. In general, they required that discharges not cause violations of water quality objectives but did not require water quality monitoring.

In May 2004, the State Water Board adopted a new policy regulating nonpoint-source pollution, known as the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, fulfilling the requirements of Water Code Section 13369(a)(2)(B). This policy affects landowners and operators throughout the state engaged in agricultural production, timber harvest operations, and other potential sources of nonpoint source pollution.

The 2004 policy generally expects nonpoint-source dischargers to use management practices that do not impair surface water quality and charges each landowner a fee to cover increased regulatory oversight. Consequently, implementation programs for nonpoint-source pollution control have expanded beyond waivers and now may be developed by a Regional Water Board, the State Water Board, individual dischargers, or by a coalition of dischargers in cooperation with a third-party representative, organization, or government agency. The latter programs are collectively known as *third-party programs*, and the third-party role is restricted to entities that are not actual dischargers under Regional Water Board/State Water Board point-discharge permitting and enforcement jurisdiction.

8.2.2.9 California Toxics Rule

As a result of a court-ordered revocation of California's statewide objectives for priority pollutants in September 1994, USEPA initiated efforts to promulgate additional numeric water quality criteria for California. In May 2000, USEPA issued the CTR that promulgated numeric criteria for priority pollutants not included in the NTR. The CTR documentation (65 FR 31682, May 18, 2000) carried forward the previously promulgated standards of the NTR, thereby providing a single document listing California's adopted and applicable water quality criteria for priority pollutants.

8.2.2.10 Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

In March 2000, the State Water Board adopted the Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP), which implemented criteria for priority toxic pollutants contained in the CTR as well as other priority toxic pollutant criteria and objectives. The SIP applies to discharges of toxic pollutants into inland surface waters, enclosed bays, and estuaries of California subject to regulation under the state's Porter-Cologne Act (Division 7 of the Water Code) and the federal CWA. Such regulation may occur through the issuance of NPDES permits or other relevant regulatory approaches. The goal of this policy is to establish a standardized approach for permitting discharges of toxic pollutants to nonocean surface waters in a manner that promotes statewide consistency. As such, SIP is a tool to be used in conjunction with watershed management approaches and, where appropriate, the development of TMDLs to ensure achievement of water quality standards (water quality criteria or objectives and the beneficial uses they are intended to protect, as well as the state and federal antidegradation policies).

SIP established: (1) implementation provisions for priority pollutant criteria promulgated by USEPA through the NTR and CTR and for priority pollutant objectives established by Regional Water Boards in their WQCPs; (2) monitoring requirements for 2,3,7,8-TCDD equivalents; and (3) chronic toxicity control provisions. In addition, the SIP includes special provisions for certain types of discharges and factors that could affect the application of other provisions in the policy.

8.2.2.11 Department of Public Health Safe Drinking Water Act Implementation

DPH is designated by USEPA as the primary agency to administer and enforce requirements of the federal SDWA in California. Public water systems are required to monitor for regulated contaminants in their drinking water supply. California's drinking water standards (e.g., MCLs) are the same or more stringent than the federal standards and include additional contaminants not regulated by USEPA. Like the federal MCLs, California's primary MCLs address health concerns, while secondary MCLs address aesthetics, such as taste and odor. The California SDWA is administered by DPH primarily through a permit system.

8.2.2.12 State Water Resources Control Board Decision 1641

The Bay-Delta WQCP (discussed previously) outlines current water quality objectives for the Delta. State Water Resources Control Board D-1641 contains the current water right requirements, applicable to DWR and Reclamation's operations of the SWP and CVP facilities, respectively, to implement the Bay-Delta water quality objectives. Objectives included in D-1641 include those related to salinity and DO, spring outflow (i.e., X2) objectives, export pumping, Delta cross-channel operations, and flow objectives in the Sacramento and San Joaquin Rivers.

Regarding X2, D-1641 specifies that, from February through June, the location of X2 must be west of Collinsville and additionally must be west of Chipps Island or Port Chicago for a certain number of days each month, depending on the previous month's Eight River Index. D-1641 specifies that compliance with the X2 standard may occur in one of three ways: 1) the daily average EC at the compliance point is less than or equal to 2.64 millimhos/cm; 2) the 14-day average EC is less than or equal to 2.64 millimhos/cm; or 3) the 3-day average Delta outflow is greater than or equal to the corresponding minimum outflow.

In D-1641, the State Water Board assigned responsibilities to Reclamation and DWR for meeting these requirements on an interim basis. These responsibilities required that SWP and CVP be operated to meet water quality objectives in the Delta, pending a water rights hearing to allocate the obligation to meet the water quality and flow-dependent objectives among all users of the Sacramento and San Joaquin River basins with appropriative water rights with post-1914 priority dates. However, in lieu of this hearing, the San Joaquin River Agreement and Sacramento Valley Water Management Agreement are settlements between Reclamation and DWR with water users upstream of the Delta, in which SWP and CVP committed to continue to meet the D-1641 water quality requirements in return for other commitments by major upstream water-rights holders. After these agreements were executed, the State Water Board cancelled the water rights hearing to allocate that responsibility.

In February 2006, the State Water Board issued a Cease and Desist Order (CDO, Water Rights Order No. 2006-0006) to DWR and Reclamation that established actions and a compliance schedule for implementation of the requirements contained in D-1641, in particular to ensure compliance with the salinity objectives for the interior southern Delta. The CDO also revised the previously issued (July 1, 2005) Water Quality Response Plan approval governing Reclamation's and DWR's Joint Point of Diversion (JPOD) operations (i.e., use of the other agency's respective point of diversion in the southern Delta). The CDO specified that the agencies may conduct JPOD operations provided that both agencies are in compliance with all of the conditions of their respective water right permits and licenses at the time that the JPOD operations would occur. The CDO was amended in January 2010 (Water Rights Order No. 2010-0002) to modify the time schedule of actions to follow the State Water Board's next review of the 2006 Bay-Delta WQCP and separate hearings completed in 2010 for the consideration of changes to the interior southern Delta salinity objectives.

D-1641 also established the Vernalis Adaptive Management Plan, (VAMP), a 12-year experimental/adaptive management program to assess effects of changes in flows and aquatic habitat resources on juvenile Chinook salmon migrating from the San Joaquin River through the Delta. This 12-year experimental/adaptive management program concluded in 2011. No formal plans for its continuation have been adopted.

SWP and CVP Coordinated Operations Agreement

SWP and CVP are relatively independent projects that use a common water supply. However, the SWP and CVP operations are linked by the requirement that they meet Delta flow and water quality standards and are linked by joint operations south of the Delta at the San Luis complex and the joint-use San Luis Canal. In 1986, Public Law 99-546 authorized the Coordinated Operations Agreement (COA) between Reclamation and DWR, intended to define the rights and responsibilities of SWP and CVP with respect to use of that common water supply and provide an infrastructure to monitor those rights and responsibilities. Specifically, the COA defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta flow and water quality standards and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review every 5 years (Bureau of Reclamation 2004).

SWP and CVP Project Water Acceptance Criteria

In consultation with SWP contractors and DHS, DWR developed acceptance criteria to govern the water quality of nonproject water conveyed through the California Aqueduct. Non-project water with chemical concentrations less than the acceptable criteria is routinely accepted by DWR. Non-project water with chemical concentrations greater than the criteria is managed on a case-by-case basis.

8.2.2.13 Central Valley Water Board Drinking Water Policy

A commitment of the CALFED Bay-Delta Program process and Record of Decision was the development of a new drinking water policy for Delta waters. Currently, both the Bay-Delta WQCP and the Sacramento–San Joaquin Basin Plan lack numeric water quality objectives for several known drinking water constituents of concern, such as organic carbon and pathogens (CALFED Bay-Delta Program 2008b). In response to the CALFED commitment, the Central Valley Water Board is in the process of a multiyear effort to develop a drinking water policy for surface waters in the Central Valley (Central Valley Regional Water Quality Control Board 2011a). Existing policies and plans lack water quality objectives for several known drinking water constituents of concern, including DBP precursors and pathogens, and also lack implementation strategies to provide effective source water protection. The new policy will culminate in the incorporation of new requirements into a Basin Plan amendment, adopted in 2013. The Central Valley Water Board Drinking Water Policy will apply to Delta waters and any activities, such as discharges, that affect Delta water quality.

8.2.3 Nonregional and Local Plans, Policies, and Regulations

The boundaries of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties include water bodies that would be most directly affected by implementation of project alternatives. The respective general plans for these counties include goals and policies regarding water resources and stormwater management, and overall water quality management, designed for protection of beneficial uses of importance within the Delta and elsewhere. Cities and counties also have developed numerous ordinances, policies, and other regulatory mechanisms for controlling stormwater drainage and related contaminant discharges to surface water bodies. General plan policies and local regulations, and potential consistency of project alternatives with such policies and regulations, are described below.

8.2.3.1 General Plan Goals and Policies

Contra Costa County General Plan

A comprehensive update to the Contra Costa County General Plan was adopted on January 18, 2005, to guide future growth, development, and resource conservation through 2020. Goal 8-T reflects the principal relevant water quality goal of the Contra Costa County General Plan, which states: "To conserve, enhance and manage water resources. Protect their water quality, and assure an adequate long-term supply of water for domestic, fishing, industrial and agricultural use." Accompanying policy 8-75 states, "Preserve and enhance the quality of surface and groundwater quality."

Sacramento County General Plan

The Sacramento County General Plan, amended on November 9, 2011, provides for growth and development in the unincorporated area through 2050. The principal goal of the Sacramento County General Plan pertaining to water resources states: "Ensure that a safe, reliable water supply is available for existing and planned urban development and agriculture while protecting beneficial uses of Waters of the state of California, including important associated environmental resources." Supporting policies include those following.

- **CO-21.** Support protection and restoration of the Sacramento River Delta.
- **CO-24.** Comply with the Sacramento Areawide National Pollutant Discharge Elimination System Municipal Stormwater Permit (NPDES Municipal Permit) or subsequent permits, issued by the Central Valley Water Board to the County, and the Cities of Sacramento, Elk Grove, Citrus Heights, Folsom, Rancho Cordova, and Galt (collectively known as the Sacramento Stormwater Quality Partnership [SSQP]).
- **CO-27.** Support surface water quality monitoring programs that identify and address causes of water quality degradation.
- **CO-28.** Comply with other water quality regulations and NPDES permits as they apply to County projects or activities, such as the State's Construction General Permit and Aquatic Pesticides Permit.
- **CO-29.** Continue to support the County's participation in regional NPDES Municipal Permit compliance activities through collaborative efforts such as the Sacramento Stormwater Quality Partnership.
- **CO-30.** Require development projects to comply with the County's stormwater development/design standards, including hydromodification management and low impact development standards, established pursuant to the NPDES Municipal Permit.

San Joaquin County General Plan

The "Resources" section of the San Joaquin County General Plan that addresses objectives and policies for water resources management was last updated in 1992 (San Joaquin County 1992). The General Plan contains the following four objectives that are directly or indirectly address protection of water quality conditions for the county:

- **Objective 1.** To ensure adequate quantity and quality of water resources for municipal and industrial uses, agriculture, recreation, and fish and wildlife.

- **Objective 2.** To obtain sufficient water supplies to meet all municipal and agricultural water needs.
- **Objective 4.** To prevent and eliminate contamination of surface and groundwater resources.
- **Objective 5.** To recognize the surface water resources of San Joaquin County as resources of the State and national significance for which environmental and scenic values must be protected

The General Plan further contains the following three specific water quality policies:

- **Policy 1.** Water quality shall meet the standards necessary for the uses to which the water resources are put.
- **Policy 2.** Surface water and groundwater quality shall be protected and improved when necessary.
- **Policy 3.** The use and disposal of toxic chemicals, the extraction of resources, and the disposal of wastes into injection wells shall be carefully controlled and monitored to protect water quality.

Solano County General Plan

The Solano County General Plan was adopted on August 5, 2008. The general plan is the guide for both land development and conservation in the unincorporated portions of the county and contains the policy framework necessary to fulfill the community's vision for Solano County in 2030. Relevant policies of the Solano County General Plan pertaining to water resources are described below.

The primary water resources goal (Goal RS.G-9) states: "Protect, monitor, restore and enhance the quality of surface and groundwater resources to meet the needs of all beneficial uses." Supporting polices include those following.

- **RS.P-64:** Identify, promote, and seek funding for the evaluation and remediation of water resource or water quality problems through a watershed management approach. Work with the regional water quality control board, watershed-focused groups, and stakeholders in the collection, evaluation and use of watershed-specific water resource information.
- **RS.P-73:** Use watershed planning approaches to resolve water quality problems. Use a comprehensive stormwater management program to limit the quantity and increase the water quality of runoff flowing to the county's streams and rivers.

Yolo County General Plan

The Yolo County 2030 Countywide General Plan was adopted on November 10, 2009, and provides for growth and development in the unincorporated area through 2030. Among all the county general plans in the Primary Zone of the Delta, Yolo County contains the most specific policies relating to protection of water resources. Relevant water resource policies and actions of the Yolo County general plan are listed below.

- **Policy CO-5.1:** Coordinate with water purveyors and water users to manage supplies to avoid long-term overdraft, water quality degradation, land subsidence and other potential problems.
- **Policy CO-5.6:** Improve and protect water quality for municipal, agricultural, and environmental uses.
- **Policy CO-5.7:** Support mercury regulations that are based on good science and reflect an appropriate balancing of sometimes competing public values including health, food chain,

reclamation and restoration of Cache Creek, sustainable and economically viable Delta agriculture, necessary mineral extraction, flood control, erosion control, water quality, and habitat restoration.

- **Policy CO-5.21:** Encourage the use of water management strategies, biological remediation, and technology to address naturally occurring water quality problems such as boron, mercury, and arsenic.
- **Policy CO-5.23:** Support efforts to meet applicable water quality standards for all surface and groundwater resources.

8.2.3.2 Local Regulations

The principal regulatory requirements for surface water quality protection at the local governmental agency level consist primarily of stormwater management programs to implement responsibilities under the statewide NPDES stormwater permits for Municipal Separate (MS) Storm Sewer Systems adopted by the State Water Board. Larger entities such as the core municipal areas of Sacramento and Stockton are regulated under individual permits (MS1 permits), whereas smaller cities and unincorporated county areas typically are regulated by the State Water Board's MS4 permit. Entities must prepare Storm Water Management Plans (SWMPs) for the stormwater NPDES permits that outline the agency actions that will be conducted to reduce the discharge of pollutants from storm drainage systems. The SWMPs must address urban runoff and construction site runoff. Additional city and county code and regulations for water quality protection typically may include grading permits, erosion and sediment control ordinances, and stormwater drainage facility design and management requirements.

8.2.3.3 Policy Consistency

The implementation of the selected alternative by the project proponent will comply with applicable stormwater management programs. In particular, as part of the environmental commitments (Appendix 3B, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*) for each alternative, project construction activities will be conducted in compliance with the State Water Board's *NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities* (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). This General Construction NPDES Permit requires the preparation and implementation of Stormwater Pollution Prevention Plans (SWPPPs) that outline the temporary construction-related BMPs to prevent and minimize erosion, sedimentation, and discharge of other construction-related contaminants, as well as permanent post-construction BMPs to minimize adverse long-term stormwater related–runoff water quality effects. Therefore, implementation of the alternatives would be anticipated to be consistent with local plans and regulations for stormwater management.

Although the state and federal project proponents and decision-makers are not required to comply with county general plans and policies, it is important for CEQA and NEPA compliance purposes to identify any relevant local land use plans, policies, and regulations that are adopted for the purpose of avoiding or mitigating an environmental effect. Potential inconsistencies with such enactments do not *per se* translate into adverse environmental effects under either CEQA or NEPA. Even where a lead agency is subject to an environmentally protective policy, the mere fact of inconsistency (a "paper" phenomenon) is not by itself an adverse effect on the environment. Such paper inconsistencies sometimes indicate, however, that a proposed physical activity might harm the environmental resource intended to be protected by the plans, policies, or regulations at issue. Potential adverse effects on such resources (e.g., water quality) are addressed in Section 8.3, *Environmental Consequences*, where the extent and significance of such effects are addressed.

8.3 Environmental Consequences

This section describes potential direct (both temporary construction-related and permanent operations-related) and indirect effects on water quality within the affected environment that would result from implementation of each alternative. For the purposes of this chapter, temporary impacts refer to those effects that are caused directly or indirectly through implementation of some temporary or intermittent activity associated with the proposed project, and thus ultimately the effect ceases to exist. Given the large scale of the potential temporary activities associated with the project, such as construction activities, it should be noted that temporary impacts may still occur over a relatively extended time period of many months or years at some project locations. An analysis of the consistency of the alternatives with applicable state water quality standards, plans, and policies, including the federally promulgated NTR and CTR, is provided for the Upstream of the Delta Region, Delta Region, and the SWP and CVP Export Service Areas Region of the affected environment. The impact analysis separates temporary construction-related impacts from those associated with long-term facilities operations for the alternatives. Each of the BDCP alternatives' proposed features are divided into two categories: physical/structural components associated with the new conveyance facilities (CM1) and their operations and maintenance, which are project-level features, and restoration actions or CM2–CM21), which are programmatic features. Alternatives 4A, 2D, and 5A are evaluated at a project level of detail.

8.3.1 Methods for Analysis

Each Alternative consists of two broad categories of actions relevant to water quality concerns. These are: (1) temporary construction activities associated with construction of the water conveyance facilities and conservation measures/Environmental Commitments and (2) non-construction-related actions associated with the water conveyance facilities and conservation measures/Environmental Commitments. The non-construction-related actions associated with the conservation measures/Environmental Commitments are further characterized by the following four major components.

1. New north Delta diversion and conveyance facilities to be operated in conjunction with SWP and CVP existing facilities (collectively called *conveyance*).

2. Detailed criteria that will govern the operations of the new SWP conveyance facilities and other in-Delta facilities across a range of hydrological conditions (collectively called operations). Number 1 and 2 together are referred to as CM1 for the BDCP alternatives, and "facilities operations and maintenance" for Alternatives 4A, 2D, and 5A.

3. Habitat Restoration: each action alternative would include a range of tidal marsh, floodplain, riparian, and upland transition habitat activities within the Plan Area (CM2–CM11 for the BDCP alternatives; Environmental Commitments 3, 4, and 6–11 for Alternatives 4A, 2D, and 5A).

4. Actions to address and control contaminants, nonnative invasive species, and predation, and to address other potentially important non-conveyance and non-habitat-related stressors on

covered species (collectively called *other stressors*) (CM12–CM21 for the BDCP alternatives; Environmental Commitments 12, 15, and 16 for Alternatives 4A, 2D, and 5A).

Implementation of the alternatives would result in changes to SWP and CVP operations, Delta habitats, channel flows, and Delta hydrodynamics (i.e., how water moves through the Delta). Implementation of conservation measures/Environmental Commitments also could directly affect water quality positively or negatively at certain locations. Thus, the components of the alternatives could collectively result in complex water quality changes within the affected environment (see Section 8.1, *Environmental Setting/Affected Environment*). For the purposes of this assessment, the study area is divided into the three regions (Figure 1-4).

- Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
- Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).
- SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta-Mendota Canal, and South Bay Aqueduct [SBA]).

Each constituent assessment and the assessment of construction-related impacts address the three regions above. In addition, a separate impact discussion is provided to address the effects of the alternatives on the San Francisco Bay.

The two key questions to be addressed by this surface water quality impact assessment are as follows.

1. Would implementation of the alternatives result in water quality changes to the Plan Area, Upstream of the Delta, or SWP/CVP Export Service Areas that would result in exceedances of water quality criteria/objectives, or substantially degrade water quality, of/by sufficient frequency, magnitude, and geographic extent as to cause or substantially contribute to significant adverse effects on the beneficial uses of water in these areas of the affected environment?
2. Would implementation of the alternatives result in beneficial effects on water quality in these areas?

Appropriately addressing these questions is a complex task because:

- The full effects of the alternatives would occur in the future, and "project effects" on water quality involve numerous constituents of interest (many having adopted water quality objectives/criteria and some without adopted objectives/criteria).
- Multiple beneficial uses could be affected by changes in water quality.
- Numerous locations of interest are found throughout the large affected environment.

Moreover, models available for use in addressing such questions have been previously developed for the effects of operations of the SWP–CVP facilities for only a few water quality parameters (e.g., EC, DOC, and temperature) in defined portions of the affected environment (i.e., the Delta), and are poorly developed or not developed at all for nearly all other water quality parameters and locations, nor for most of the conservation measures proposed for implementation. Consequently, the methodology developed for assessing water quality impacts differed for each of the three areas of the affected environment because:

- The beneficial uses of water in each area are affected differently by the alternatives.

- Each area has different constituents of concern and different historical data availability for those constituents.
- The availability of models that can be used to support quantitative assessments differs in each area.

Hence, a combination of both quantitative and qualitative analyses (as appropriate) was performed to estimate the changes in water quality attributable to implementation of the alternatives within the three areas of the affected environment. Depending on the constituent and location, these changes could be significant/adverse (e.g., increase in concentration or mass loading of harmful constituents), insignificant, or beneficial.

In general, the fewest water quality changes of importance are expected to occur Upstream of the Delta, followed by the SWP/CVP Export Service Areas, with the greatest number and magnitude of water quality changes expected for the Plan Area. The Plan Area was analyzed in the greatest detail for the following reasons.

- Its water quality would be most affected by the action alternatives.
- It has complex hydrodynamic characteristics.
- Models are available to simulate hydrodynamic and water quality changes within the Delta region.
- Delta water quality is critically important to the water supplies of California residents that use water within the Delta and in the SWP/CVP Export Service Areas.

All constituents for which data were compiled were run through an initial screening analysis that determined the appropriate levels of analysis needed for each constituent, and whether further analysis beyond that provided by the screening analysis itself, if needed, would be qualitative or quantitative. The details of the screening analysis are discussed later in this section.

The constituents of concern in the affected environment included both physically and chemically conservative and non-conservative parameters. The concentrations of conservative constituents tend to not be affected substantially by physical, chemical, or biological mechanisms that would result in a loss of the constituent from the system. Thus, the concentrations of conservative constituents can be reasonably estimated and changes assessed with mass-balance accounting of the mixing of known volumes and concentrations of different water sources. Non-conservative constituents can be affected by mechanisms that result in loss from the water such as physical (e.g., settling, volatilization), chemical (e.g., adsorption, oxidation-reduction, complexation), or biological (e.g., uptake, decay) mechanisms such that mass-balance accounting becomes much more complex. Historical monitoring data for the majority of these constituents were collected and reviewed from various locations of interest within the affected environment.

Conservative parameters were evaluated using available models used for SWP/CVP planning and operations (i.e., California Water Resources Simulation Model [CALSIM II, Delta Simulation Model 2 [DSM2], and Reclamation's Temperature Model) wherever applicable, as well as constituents directly addressed by these models, and included EC, DOC, and temperature. It should be noted that because aquatic life beneficial uses are the only uses expected to be affected by temperature changes under the various alternatives, the water quality chapter cross-references to Chapter 11, *Fish and Aquatic Resources*, for all impact assessments for temperature.

These models produce detailed estimates of existing and future flow and water quality conditions for the major reservoir, river, Delta, and constructed features such as agricultural diversions, municipal diversions, and associated conveyance facilities within the study area. As such, the CALSIM and DSM2 model outputs also were used to support quantitative mass-balance assessments for several other constituents that exhibit generally conservative characteristics. Non-conservative parameters were evaluated qualitatively. Detailed discussion on when and where qualitative or quantitative analyses were performed is included later in this section.

Mercury and selenium were analyzed in detail because of their bioaccumulative properties. Bioaccumulation refers to the uptake of a constituent by a biological organism which exceeds the excretion or loss from the organism, such that concentrations within the organism are increased over time. The specific methodologies used to evaluate these two parameters are discussed separately in this section. Various models used in analyzing these constituents of interest and their interrelationship have also been discussed in detail.

Based on the components of the alternatives (described previously in this section), three categories of potential changes in water quality conditions are described, as follows.

- Changes attributable to construction-related conservation measures/Environmental Commitments.
- Changes attributable to operations and maintenance of new conveyance facilities and new SWP and CVP operational criteria.
- Changes attributable to non-construction related actions associated with implementation of other defined conservation measures/Environmental Commitments.

It was determined that the action alternatives would result in all three categories of potential water quality effects within the Plan Area. However, based on the description of alternatives (see Chapter 3, *Description of Alternatives*) for construction activities and conservation measures/Environmental Commitments in the Upstream of the Delta and the SWP/CVP Export Service Area, water quality changes were expected to be minimal and, hence, are not addressed in as much detail. For those alternatives that include specific water conveyance facilities measures in the Plan Area, however, a project specific level of analysis is included.

The frequency, magnitude, and geographic extent of any change in specific water quality constituents, or change in mass loading, is of primary importance in determining effects on beneficial uses (aquatic biology, municipal and domestic supply, agricultural uses, recreation, etc.). Consequently, findings regarding estimated concentrations at each assessment location for individual constituents of concern under the alternatives were compared to thresholds of significance (Section 8.3.2, *Determination of Effects*) for the purposes of making CEQA and NEPA impact determinations. Thresholds of significance define the criteria used to define the level at which an impact would be considered significant in accordance with CEQA and NEPA. Thresholds were based on the checklist in Appendix G of the CEQA Guidelines (CCR, Title 14, Division 6, Chapter 3), scientific information and data, and regulatory standards. These thresholds take into account the factors under NEPA to determine the significance of an action in terms of the context and intensity of its effects (40 CFR 1508.27).

If the estimated water quality conditions for a constituent under an Alternative triggers one or more of the five water quality conditions defined as effects assessment criteria (NEPA) and thresholds of significance (CEQA) (see Section 8.3.2.3, *Effects Determinations*) at one or more of the assessment locations, then that Alternative was determined to have an adverse water quality effect (under NEPA) and a significant impact on water quality (under CEQA) for that water quality constituent or parameter. Improvements to water quality conditions, where modeled or estimated to occur, also were generally identified as beneficial if considered to reflect a substantial change.

In summary, the impact assessment methodology includes the following:

1. Addresses all constituents of concern based on available information and the current science regarding concentrations/levels that would affect beneficial uses of waters within the affected environment.
2. Quantitatively evaluates constituents of primary concern where modeling tools were developed and were available for doing so, and qualitatively assesses effects where appropriate modeling tools were unavailable.
3. Evaluates the overall effect of the alternatives on beneficial uses in a comparative manner throughout the affected environment, during three distinct time frames, which address climate change considerations.

The details of this methodological approach are discussed below. In the following sections, the specific methodologies used to assess water quality impacts within the three distinct areas of the affected environment (i.e., Upstream of the Delta, Plan Area, and SWP/CVP Export Service Areas) are discussed.

8.3.1.1 Models Used and Their Linkages

The models used in support of the quantitative water quality analyses were: (1) Reclamation and DWR's CALSIM II hydrologic model; and (2) DWR's DSM2. A description of each model is provided below, including a discussion of how the models were used to assess compliance with water quality objectives for EC and chloride in the Delta, as well as how results from these models were used to quantify changes in other water quality constituent concentrations/parameter levels. More information on these models and the assumptions included in their application is described in Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*.

CALSIM II

The CALSIM II model, which has been jointly developed and maintained by DWR and Reclamation to provide hydrologic-based information for planning, managing, and operating the integrated SWP and CVP system, was used to simulate system operations and resulting hydrologic conditions under the alternatives. CALSIM II operates on a monthly time step from water year 1922 through 2003 using historical rainfall and runoff data which have been adjusted for changes in water and land uses that have occurred or are projected to occur in the future. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to ensure the flow and water quality requirements for these systems are met. The model assumes that facilities, land uses, water supply contracts, and regulatory requirements are constant throughout the 82-year hydrologic period of record, thus providing a simulation representing a fixed level of development. Among other output, CALSIM II provides end-of-month reservoir storage levels, and mean monthly reservoir releases, flows at various locations along the major rivers, X2 location, Delta inflow, and Delta outflow for the 82-year hydrologic period of record.

The 2010 version of CALSIM II was used to model the SWP and CVP system and, thus, support the assessments in this chapter. This differs from the version being used to support the Biological Assessment being prepared for the proposed project, which is the 2015 version of CALSIM II. For the reasons described in Appendix 5F, the modeling results presented herein may differ from those presented in the Biological Assessment; however, the nature of those differences would not lead to different impact conclusions from those presented herein. Input assumption details for each scenario modeled using CALSIM II are provided in Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*.

The primary linkage of these models is for CALSIM II output to serve as input to DSM2, as shown in Figure 8-50. Key considerations in the CALSIM II modeling logic for the water quality assessment include how CALSIM II operations rules are configured to meet particular Delta water quality objectives for salinity and how daily patterning techniques were applied to the monthly CALSIM II operations. These topics are addressed further below.

Artificial Neural Network for Flow-Salinity Relationship

Flow-salinity relationships in the Delta are critical to both SWP/CVP and ecosystem management. Operation of the SWP/CVP facilities and management of Delta exports are often dependent on Delta flow needs for meeting salinity standards. Salinity in the Delta cannot be simulated accurately by the simple mass-balance routing and coarse time-step used in CALSIM II. An Artificial Neural Network (ANN) has been developed (Sandhu et al. 1999) that attempts to mimic the flow-salinity relationships as simulated in DSM2, but provides a rapid transformation of this information into a form usable by the CALSIM II operations model. The ANN is implemented in CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps in order to satisfy particular salinity requirements. A more detailed description of the use of ANNs in the CALSIM II model is provided in Wilbur and Munévar (2001: Chapter 7).

The flow-salinity ANN developed by DWR (Sandhu et al. 1999, Seneviratne and Wu 2007) attempts to statistically correlate the salinity results from a particular DSM2 run to the various peripheral flows (Delta inflows, exports and diversions), gate operations, and an indicator of tidal energy. The ANN is calibrated, or trained, on DSM2 results that represent a specific Delta configuration using a full circle analysis (Seneviratne and Wu 2007). For example, a future reconfiguration of the Delta channels to improve conveyance may significantly affect the hydrodynamics of the system. The ANN would be able to represent this new configuration by being retrained by DSM2 results that included the new configuration. The ANN approximates DSM2-generated salinity at the following key locations for the purpose of modeling Delta water quality standards: Sacramento River at Emmaton, San Joaquin River at Jersey Point, Sacramento River at Collinsville, and Old River at Rock Slough. In addition, the ANN is capable of providing salinity estimates for Clifton Court Forebay, CCWD Alternate Intake Project (AIP) and Los Vaqueros diversion locations. The ANN may not fully capture the dynamics of the Delta under conditions other than those for which it was trained. It is possible that the ANN will exhibit errors in flow regimes beyond those for which it was trained. Therefore, a new ANN was developed for scenarios with sea level rise and/or restoration areas in the Delta which result in changed flow–salinity relationships in the Delta. A more complete description of the ANNs developed and used is included in Appendix 5A, Section A.5.3.

Monthly-to-Daily Patterning for Sacramento River at Freeport

In an effort to better represent the sub-monthly flow variability, particularly in early winter, a monthly-to-daily flow patterning technique is applied directly in CALSIM II for the Fremont Weir, Sacramento Weir, and the north Delta intakes. The technique applies historical daily patterns, based on the hydrology of the year, to transform the monthly volumes into daily flows. In all cases, the monthly volumes are preserved between the daily and monthly flows. It is important to note that this daily patterning approach does not in any way represent the flows resulting from operational responses on a daily time step. It is simply a technique to incorporate representative daily variability into the flows resulting from CALSIM II's monthly operational decisions to help provide a better estimate of the Fremont and Sacramento weir spills, which are sensitive to the daily flow patterns and provides the upper bound of the available north Delta diversion in the alternatives. The incorporation of daily patterning in CALSIM II is described in the Section A.3.3 of Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*.

DSM2

DSM2 is a one-dimensional mathematical model for dynamic simulation of hydrodynamics, water quality, and particle tracking throughout the Delta. DSM2 can be used to calculate stages, flows, velocities, mass transport processes for conservative constituents, and transport of individual particles. The model runs on a 15-minute time step for a 16-year hydrologic period of record. DSM2 currently consists of three modules: HYDRO, QUAL, and PTM. HYDRO simulates one-dimensional hydrodynamics including flows, velocities, depth, and water surface elevations. HYDRO provides the flow input for QUAL and PTM. QUAL simulates one-dimensional fate and transport of conservative water quality constituents given a flow field simulated by HYDRO. PTM simulates pseudo three-dimensional transport of neutrally buoyant particles based on the flow field simulated by HYDRO. Input assumption details for each scenario modeled are provided in Appendix 5A.

Simulation Period

DSM2 was utilized to simulate the 16-year, 1976–1991 hydrologic period of record. This hydrologic period of record contains a sequence of water years that contains all water year types: wet, above normal, below normal, dry, and critical. This hydrologic period is bracketed at each end by two critical years: 1976 and 1977 at the beginning of the period and 1990 and 1991 at the end of the period. This hydrologic period also contains an extended drought period, 1987–1991. Additional information regarding the selection of the simulation period is provided in Appendix 5A, Section D (Additional Modeling Information).

Monthly-to-Daily Patterning

DSM2 is simulated on a 15-minute time step to address the changing tidal dynamics of the Delta system. However, the boundary flows, which are provided from CALSIM II output, are mean monthly flows. As shown in Figures A-6 and A-7 of Appendix 5A, Sacramento River flow at Freeport exhibits significant daily variability around the monthly mean in the winter and spring periods in most water year types. The winter-spring daily flow variability is deemed important to aquatic species of concern. To better represent the sub-monthly flow variability, particularly in early winter, a monthly-to-daily flow patterning technique was applied to the boundary flow inputs to DSM2. The monthly-to-daily flow patterning approach used in CALSIM II and DSM2 are consistent. A detailed description of the implementation of the daily variability in DSM2 boundary flows is provided in Appendix 5A, Section D.9.

It is important to note that this monthly-to-daily patterning approach does not in any way represent the flows that would result from any operational responses on a daily time step. It is simply a technique to incorporate representative daily variability into the flows resulting from CALSIM II's monthly operational decisions.

Calibration and Validation

DSM2 hydrodynamics and salinity (EC), which is directly modeled by DSM2, were initially calibrated in 1997 (California Department of Water Resources 1997). In 2000, a group of agencies, water users, and stakeholders recalibrated and validated DSM2 in an open process resulting in a model that could replicate the observed data more closely than the 1997 version (DSM2PWT 2001). In 2009, CH2M HILL performed a calibration and validation of DSM2 by including the flooded Liberty Island in the DSM2 grid, which allowed for an improved simulation of tidal hydraulics and EC transport in DSM2 (CH2M HILL 2009). The technical report documenting this calibration and validation effort is included in Appendix 5A, Section D.5. Simulation of DOC transport in DSM2 was successfully validated in 2001 by DWR (Pandey 2001). The version of DSM2 used for evaluating the alternatives incorporates these latest calibrations.

Corroboration

To evaluate DSM2's ability to represent the effects of sea level change and the proposed restoration actions on Delta hydrodynamics and salinity, DSM2 results were compared with results from two other Delta simulation models. The effects of sea level rise were simulated by the three-dimensional UNTRIM Bay-Delta model and the effects of tidal marsh restoration were simulated by the two-dimensional RMA Bay-Delta model. Detailed descriptions of the UnTRIM modeling of the sea level rise scenarios, RMA modeling of the tidal marsh restoration, and DSM2 corroboration are included in Appendix 5A, Sections D.7, D.6, and D.8, respectively. Overall the results show that DSM2 is capable of simulating similar incremental changes in flows and salinity at most Delta locations as in the RMA model. Further, DSM2 is capable of simulating similar incremental changes in salinity as UnTRIM in the west Delta where sea level rise is expected to have an influence.

Modeling Limitations and Uncertainty

Because DSM2 is a one-dimensional model, it has inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment such as the Delta. DSM2 assumes that velocity in a channel can be adequately represented by a single average velocity over the channel cross-section, meaning that variations both across the width of the channel and through the water column are negligible. DSM2 does not have the ability to model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly account for dispersion due to flow accelerating through channel bends. It cannot model the vertical salinity stratification in the channels. It has inherent limitations in simulating the hydrodynamics related to the open water areas. Since a reservoir surface area is constant in DSM2, it impacts the stage in the reservoir and thereby impacting the flow exchange with the adjoining channel. Due to the inability to change the cross-sectional area of the reservoir inlets with changing water surface elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This causes errors in the flow exchange at breaches during the extreme spring and neap tides. Using an arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs. Accurate representation of tidal marsh areas, bottom elevations, location of breaches, breach widths, cross-sections, and boundary conditions in DSM2 is critical to the corroboration with RMA results for tidal marsh areas.

For open water bodies DSM2 assumes uniform and instantaneous mixing over an entire open water area. Thus it does not account for the salinity gradients that may exist within the open water bodies. Significant uncertainty exists in flow and EC input data related to in-Delta agriculture, which leads to uncertainty in the simulated EC values. Caution needs to be exercised when using EC outputs on a sub-monthly scale. Water quality results inside the water bodies representing the tidal marsh areas were not validated specifically. Additionally, localized withdrawals and returns are not simulated for Suisun Marsh in DSM2. In some areas of Suisun Marsh where these play a major role in water quality, DSM2 modeling may not be accurate.

Notwithstanding the above limitation, DSM2 remains the best available tool from which to simulate water quality changes within the Delta over an extended hydrologic period.

Use of CALSIM II and DSM2 for Assessment of Meeting of Bay-Delta WQCP Water Quality Objectives

Water Quality Objectives Incorporated into CALSIM II

In CALSIM II, the reservoirs and facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met. Meeting regulatory requirements, including Delta water quality objectives, is the highest operational priority in CALSIM II. As mentioned above, CALSIM II uses an ANN to configure system operations to meet salinity objectives. Because CALSIM II operates on a monthly time step, the model attempts to meet these objectives on a monthly average basis, even though the objectives themselves are often based on 14-day or 30-day running averages, and may start or end in the middle of a month. The ANN can only predict salinity at a few of the locations that have water quality objectives for salinity, which are specific to Delta beneficial uses:

- Municipal and Industrial Use:
    - Old River at Rock Slough
    - Banks/Jones Pumping Plants
- Agricultural Beneficial Use:
    - Sacramento River at Emmaton or Threemile Slough
    - San Joaquin River at Jersey Point
- Fish and Wildlife Beneficial Uses:
    - Sacramento River at Collinsville

At the locations denoted above, because meeting the objectives is the highest priority in CALSIM II, only two conditions in CALSIM II are possible: (1) applicable water quality objectives are met on a monthly average basis according to the ANN, or (2) there is no feasible way to meet the objective.

Note that the certain alternatives contain an important element regarding the Sacramento River at Emmaton water quality objective. Alternatives 1A–C, 2A–C, 3, 5, 6A–C, 7, 8, and 9 include, as part of the definition of the alternative, a change in the compliance point to the Sacramento River at Threemile Slough. The ANN for these alternatives was retrained based on this change, so CALSIM II operated in such a way as to meet this objective at Threemile Slough under these alternatives. The Existing Conditions and No Action Alternative did not include this change to the compliance point or ANN. Also, for Alternatives 4, 4A, 2D, and 5C, the Sacramento River at Emmaton compliance location is retained.

Threemile Slough is located approximately two and one-half miles upstream of Emmaton. Because of their relative locations, when the EC water quality objective is met at Emmaton, it is generally also met at Threemile Slough. However, it is not always the case that meeting the objective at Threemile Slough results in meeting the objective at Emmaton, because the Threemile Slough is further upstream from the effects that salinity intrusion can have on EC. Thus, under the alternatives that include a change in compliance location from Emmaton to Threemile Slough, there are more exceedances of the water quality objective at Emmaton (were it to be still in place) than under the Existing Conditions or No Action Alternative (which do have the compliance location at Emmaton).

When DSM2 is run using the output from CALSIM II, exceedances of the water quality objectives above can occur for the reasons below.

1. CALSIM II found no feasible way to meet the objective – i.e., both CALSIM II and DSM2 agree that the objective is exceeded.
2. The ANN that CALSIM II uses predicted that the objective would be met on a monthly average basis under the operations simulated in CALSIM II, but either:
    a. The ANN is an imperfect predictor of compliance generally, or specifically on the time-step and averaging basis by which these objectives are defined; or
    b. The monthly-to-daily patterning discussed above resulted in a pattern of flows at the DSM2 boundary conditions that resulted in the objective being exceeded.

In the water quality analysis, if exceedances of these objectives were predicted via the DSM2 results, depending on the specific objective in question, various approaches were employed to determine if the exceedances fell into reason 1 or 2 above. If they fell into reason 2 (i.e., objective met in CALSIM II), additional sensitivity analyses were performed to determine if changes in modeling assumptions or operational changes could result in compliance with the objective. Additional information regarding these analyses is provided in Appendix 8H, *Electrical Conductivity*, Attachments 1 and 2.

Water Quality Objectives not Incorporated into CALSIM II

There are also water quality objectives for salinity that are not incorporated into the ANN and CALSIM II. These include objectives that apply for the following beneficial uses and locations:

- Municipal and Industrial Use:
    - Cache Slough at City of Vallejo Intake
    - Barker Slough at North Bay Aqueduct Intake
- Agricultural Beneficial Use:
    - Interior Delta
        - South Fork Mokelumne River at Terminous
        - San Joaquin River at San Andreas Landing
    - Southern Delta and Export Area

        - San Joaquin River at Airport Way Bridge, Vernalis
        - San Joaquin River at Brandt Bridge Site
        - Old River near Middle River
        - Old River at Tracy Road Bridge
        - West Canal at mouth of Clifton Court Forebay
        - Delta-Mendota Canal at Tracy Pumping Plant
- Fish and Wildlife Beneficial Uses:
    - San Joaquin River at and between Jersey Point and Prisoners Point
    - Suisun Marsh
        - Sacramento River at Collinsville
        - Montezuma Slough at National Steel
        - Montezuma Slough near Beldon's Landing
        - Chadbourne Slough at Sunrise Duck Club
        - Suisun Slough, 300 feet south of Volanti Slough
        - Cordelia Slough at lbis Club
        - Goodyear Slough at Morrow Island Clubhouse
        - Water supply intakes for waterfowl management areas on Van Sickle and Chipps Islands

Although CALSIM II does not specifically operate to meet these objectives, they are nonetheless often if not always incidentally met when DSM2 is run using the CALSIM II output as boundary conditions. Meeting of some of these objectives is not directly related to operations that CALSIM II simulates. For example, some of these objectives relate more to discharges and local sources of salinity, as opposed to system-wide operation. Others, specifically the fish and wildlife objectives in Suisun Marsh, are based on sub-daily (i.e., high tide) EC values, and also take into account other factors related to effects on wildlife when evaluating exceedance of an objective, and thus CALSIM II cannot operate to specifically meet the objective. When DSM2 is run using the output from CALSIM II, exceedances of the water quality objectives above can occur for the following reasons.

1. The exceedances are real reflections of water quality conditions for the given scenario due to system operations simulated in the CALSIM II model run and other assumptions inherent in the DSM2 run.
2. The system operations that CALSIM II simulated were incidentally sufficient to meet the water quality objective on a monthly average basis, but the monthly-to-daily patterning discussed above resulted in a pattern of flows at the DSM2 boundary conditions that resulted in the objective being exceeded.

In the water quality analysis, if exceedances of these objectives were predicted via the DSM2 results, depending on the specific objective in question, various approaches were employed to determine if the exceedances fell into reason 1 or 2 above. If they fell into reason 1 (i.e., exceedances are due to system operations), additional sensitivity analyses were performed to determine if changes in modeling assumptions or operational changes could result in compliance with the objective.

Additional information regarding these analyses is provided in Appendix 8H, *Electrical Conductivity*, Attachments 1 and 2.

Real-Time Operations of the SWP and CVP

In reality, staff from DWR and Reclamation constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. In Section 8.1.3.4 and 8.1.3.7, the history of compliance with Delta water quality objectives is summarized and discussed. In the 30-plus year history of the water quality standards, there are relatively few instances in which water quality objectives were exceeded when SWP and CVP operations had any ability to prevent the exceedance (see Sections 8.1.3.4 and 8.1.3.7 for more detail). Environmental conditions arise that cannot be foreseen or simulated in the model that can affect compliance with water quality objectives. These include unpredictable tidal and/or wind conditions, gate failures, operational needs to improve fish habitat/conditions, and prolonged extreme drought conditions, among others. At times, negotiations with the State Water Resources Control Board occur in order to effectively maximize and balance protection of beneficial uses and water rights. These activities are expected to continue in the future. Thus, it is likely that some objective exceedances simulated in the modeling would not occur under the real-time monitoring and operational paradigm that will be in place to prevent such exceedances.

8.3.1.2 Upstream of the Delta Region

Water quality changes in the affected environment upstream from the north-Delta boundary, which includes the Sacramento River to Shasta Lake, the Feather River to Lake Oroville, and the American River to Folsom Lake, were primarily assessed qualitatively. Assessment of water quality changes was limited to facilities operations-related water quality changes for all alternatives, and the implementation of CM2–CM21 for the BDCP alternatives or Environmental Commitments under Alternatives 4A, 2D, and 5A. Conveyance facility construction-related effects are not anticipated upstream of the Delta.

The assessment of water quality changes in water bodies upstream of the Delta relied, in part, on making determinations as to how reservoir storage and releases would be changed. Specific changes in reservoir storage and releases were determined from CALSIM II modeling of the SWP and CVP system (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*, describes the CALSIM II modeling performed in support of this assessment). Reservoir storage and river flow changes were then evaluated to make determinations regarding the capacity for the affected water bodies to provide dilution of watershed contaminant inputs. Also, if a particular parameter was found to be correlated to seasonal reservoir levels or river flows, how the parameter would be altered seasonally by operational changes in reservoir levels or river flows was assessed.

8.3.1.3 Plan Area

Water quality changes in the Delta were assessed quantitatively to the extent that data and models were available to do so; otherwise, water quality changes were assessed qualitatively. Using the methodology described below, changes in boron, bromide, chloride, mercury, methylmercury, nitrate, organic carbon, and selenium within the Delta were determined quantitatively at

11 assessment locations (Figure 8-7), while electrical conductivity and chloride were assessed at D-1641 compliance locations.

Operations-related water quality changes (i.e., CM1 under the BDCP alternatives) would be partly driven by geographic and hydrodynamic changes resulting from restoration actions (i.e., altered hydrodynamics attributable to new areas of tidal wetlands (CM4), for example). There is no way to disentangle the hydrodynamic effects of CM4 and other restoration measures from CM1, since the Delta as a whole is modeled with both CM1 and the other conservation measures implemented. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects were included in the modeling assessment of operations-related water quality changes (CM1 under the BDCP alternatives). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a water quality constituent to the Delta, are discussed within the impact heading for CM2–CM21.

Methodologies to determine the effects attributable to construction activities and actions to address the other stressors are discussed later in this section.

Constituent Screening Analysis

Constituents assessed in the water quality chapter were identified based on the following considerations.

- Availability of historical monitoring data.
- Constituents having adopted federal water quality criteria or state water quality objectives.
- Constituents on the state's CWA Section 303(d) list in the Delta.
- Constituents identified in public scoping comments.
- Constituents deserving assessment based on professional judgment.

A constituent *screening analysis* was conducted on 182 water quality constituents/parameters. The screening analysis determined which constituents had no potential to exceed the thresholds of significance by implementation of the alternatives and, thus, did not warrant further assessment. This analysis identified a list of "constituents of concern" that were further analyzed as part of assessing their potential water quality related impacts under the alternatives. For a detailed description of the approach employed in the constituent screening analysis, see Appendix 8C, *Screening Analysis*.

Determining Whether Assessment is Qualitative or Quantitative

For many constituents, lack of adequate representative data precluded a quantitative assessment. Tables SA-8 and SA-9 of Appendix 8C identify the types of constituents that were carried forward for detailed analysis and were automatically determined to be assessed qualitatively. For constituents for which at least one data point in the representative data set was a detected value (see Table SA-7, Appendix 8C), the assessment was either quantitative or qualitative, depending on three factors: (1) adequacy of data to perform a quantitative assessment, (2) adequacy of modeling tools, relative to the physical/chemical properties of the constituent, to perform a quantitative assessment, and availability of these tools, and (3) whether a quantitative analysis was necessary to perform the assessment.

Available tools were considered appropriate for modeling only those constituents that could be assumed to be conservative. Other gain/loss mechanisms were accounted for and addressed qualitatively within the quantitative modeling-based assessment. Constituents of concern that could not be analyzed through quantitative modeling were carried forward for qualitative analysis. Appendix 8C, Table SA-11 contains a list of water quality constituents for which individual assessments were performed and denotes the constituents that were assessed quantitatively through modeling and those that were assessed qualitatively.

Quantitative Assessments

Using the methodology described below, changes in water quality were determined at 11 assessment locations across the Delta (Figure 8-7) for each of the constituents assessed quantitatively, with the exception of EC. Assessment locations for EC aligned with compliance locations contained in the Bay-Delta WQCP and are described in further detail below. Chloride was also assessed at Bay-Delta WQCP compliance locations, in addition to the 11 other assessment locations.

Calculation of Changes in Constituent Levels

Output from DSM2 was used to calculate changes in constituent concentrations as they would be affected primarily from operations-related actions of the conveyance features of the alternatives. DSM2 produced: (1) flow-fraction or "fingerprinting" output; and (2) EC and DOC concentrations for specified Delta locations. Because the DSM2 model directly simulated EC and DOC concentrations throughout the Delta, the estimated concentrations of these constituents were simply compared among alternatives for impact assessment purposes. Additionally, because DSM2 accounts for hydrodynamic conditions in the Delta, the effects of some of the habitat restoration actions (i.e., CM2 and CM4) on EC and DOC are evaluated quantitatively. Restoration actions that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed in constituent-specific impact assessment sections as operations-related water quality changes. Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively.

The methods described in the following sections were used to calculate levels/concentrations for water quality parameters on a daily or monthly average basis for the DSM2 period of record (1976–1991). Results were generally compiled and presented based on two averaging periods: all water years, and the drought period (water years 1987–1991). The drought period was chosen to represent water quality in "worst-case" conditions, as it includes several dry and critical years in sequence. This was done in lieu of calculating water quality effects on a water year type basis (using the Sacramento River Water Year Hydrologic Classification Index). The reasons for this included simplicity of presenting and discussing results, and also because the 1987–1991 drought period represents truly worst-case conditions, whereas discussion of dry or critical year water types includes individual years when water supply and quality would not be significantly affected because they were preceded and succeeded by wet or above normal water years (e.g., 1981, 1985). However, when necessary, analysis of effects during certain water year types was conducted (for example, for chloride and EC, whose water quality standards depend on the water year type).

In the following sections, the validity and/or validation studies that have been performed for the various modeling approaches are discussed. It must be noted that comparison of modeling results for Existing Conditions to historical water quality monitoring data is not an appropriate means of model validation. SWP/CVP operations have changed several times in the past as a result of various legal and regulatory determinations, and also vary as a result of changing land uses and water demands over time. Historical water quality data in general can represent times when the SWP/CVP system was operated differently than under the simulated Existing Conditions model run, which represents operation of the SWP and CVP at the time the Notice of Preparation was issued. The modeled Existing Conditions overlays this operational scheme on a period of varied historical hydrology. Therefore, it is not expected that the modeled Existing Conditions will approximate historical water quality data at a given location or time.

Mass-Balance Method

For constituents assessed quantitatively (See Appendix 8C, *Screening Analysis*, Table SA-11) for which concentrations were not directly estimated by DSM2—boron, bromide, chloride, mercury, methylmercury, nitrate, selenium—mean monthly flow-fraction output from DSM2 was used in mass-balance calculations (processed outside of DSM2) to estimate constituent concentrations. The flow-fraction output from DSM2 is the average percentage of water at each specified Delta location that was constituted by the five primary source waters (i.e., Sacramento River [SAC], San Joaquin River [SJR], eastside tributaries [EST], San Francisco Bay [BAY], and agriculture [AGR]). These flow-fractions were used together with source water constituent concentrations derived from historical data to estimate a given constituent concentration at assessment locations according to equation 1:

$$f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR}) = C_i \quad \textbf{(1)}$$

In the above equation, $f_{X,i}$ is the mean monthly flow fraction from source X at assessment location i, C_X is the constituent concentration from source X, and C_i is the constituent concentration at assessment location i. Contribution from the Yolo Bypass was added to contribution from the Sacramento River to constitute a single source, except in the case of selenium. Source water concentrations in the above equation are described for each of the constituents assessed via this method in Section 8.3.1.7, *Constituent-Specific Considerations Used in the Assessment*. Source water concentrations may vary seasonally, and this was examined. In some cases, source water concentrations were varied seasonally based on historical trends.

A key assumption for the mass-balance calculation is that the constituent acts in a conservative manner throughout the system, as the various source waters mix and flow through the Delta, although most behave, to some degree, in a nonconservative manner. For constituents where this assumption does not hold because of decay, uptake, or other losses, this mass-balance method would be expected to overestimate the actual concentrations at any given Delta location. The mass-balance method for calculating constituent concentrations in the Delta was validated in 2011 and 2012 for chloride and bromide (MWH 2011; Liu and Suits 2012). There was one key difference, however, between the validation study methodology and the method used in this water quality assessment. In the validation study, the chloride and bromide concentrations for the Delta source waters (Sacramento River, San Joaquin River, East Side Streams, and San Francisco Bay/Martinez) were determined via regression equations relating the chloride or bromide concentration to modeled EC in the source waters. Thus, the source water concentration for chloride and bromide varied with each time step according to the EC at the boundaries. In this assessment, source water concentrations were not dependent on EC, but were either static (if review of historical data indicated little to no seasonality), or varied by month (if review of historical data indicated seasonality).

Because the bromide and chloride concentrations are relatively constant for the Sacramento River and East Side Streams, the mass-balance method is believed to be valid for modeling these. Likewise, although bromide and chloride from the San Joaquin River vary, the variations are small enough that for the purposes of this comparative study, the method is believed to be valid for San Joaquin River contributions to constituent concentrations in the Delta. However, this method does introduce uncertainty for areas influenced by San Francisco Bay contributions. This is because it is recognized that C_{BAY} in Equation 1 is dependent on flows in the Sacramento and San Joaquin Rivers as well as Delta exports (i.e., net Delta outflow), which may change due to climate change/sea level rise, and altered operations of the SWP/CVP system. It is also dependent on the tidal exchange volume, which may change as a result of restoration associated with CM4. However, beyond accounting for seasonal trends in the historical data, neither of these factors was taken into account in determining a constituent concentration for C_{BAY}. Therefore, for cases in which net Delta outflow increases or decreases relative to what has historically occurred, the constituent concentration used for C_{BAY} may overestimate or underestimate the concentrations associated with San Francisco Bay water (as measured at Martinez). Additionally, if restoration component CM4 increases tidal exchange volume, the value used for C_{BAY} would underestimate concentrations associated with San Francisco Bay water (as measured at Martinez).

Finally, it must be noted that no formal validation studies have been performed to validate the mass-balance method that was used for boron, mercury, methylmercury, nitrate, or selenium. The validation studies performed to date on conservative constituents (e.g., EC, chloride, bromide) have validated the approach for using DSM2 to evaluate changes in mixing of Delta source waters on water quality constituents. Although it is known that mercury, methylmercury, and selenium do not behave conservatively in the Delta, the mass-balance method is believed valid for assessing the impact of changed source water mixing on concentrations of these species, because the same mixing mechanisms apply to all dissolved constituents, and altered mixing of Delta source waters is one of the primary mechanisms by which the alternatives change water quality in the Delta. The model results are not meant to be taken as predictions of future mercury, methylmercury, or selenium concentrations, since known mechanisms such as sorption, settling, and transformation are not quantitatively taken into account, but rather are to be used to assess water quality differences between alternatives and to make determinations regarding potential effects on beneficial uses relative to assessment baselines.

Regression Method for Chloride and Bromide

For chloride, the quantitative assessment applied relationships between EC and chloride developed based on historical water quality data to the DSM2 output for EC. This relationship was developed based on data at Mallard Island, Jersey Island, and Old River at Rock Slough (Contra Costa Water District 1997). The relationship was:

$$Cl = max\begin{pmatrix} 0.15 * EC - 12 \\ 0.285 * EC - 50 \end{pmatrix} \qquad \textbf{(2)}$$

In the equation above, Cl is the chloride concentration in mg/L, and EC is in µS/cm.

The chloride regression method was developed using data for the west Delta and is thus valid for that area (Contra Costa Water District 1997). The chloride regression method has not been validated for other areas of the Delta. However, chloride poses the greatest risk of environmental impacts under the alternatives in the west Delta where sea water intrusion has the greatest potential to increase chloride concentrations. If the results of this method indicated that there may be environmental impacts in other areas of the Delta, further assessment was conducted to determine if the method is valid or if another method is more appropriate.

For bromide, the same EC to chloride relationship was used, followed by a relationship between chloride and bromide, to estimate bromide concentrations. The chloride to bromide relationship is approximately the same in multiple areas in the west Delta, including Old River at Rock Slough (Contra Costa Water District 1997), the intakes at Banks Pumping Plant (CALFED 2007a), and Mallard Island (Appendix 8E, *Bromide*, Figure 1). The relationship used was:

$$Br = 0.0035 * Cl \quad \textbf{(3)}$$

In the equation above, Br is the bromide concentration in mg/L, and Cl is the chloride concentration in mg/L.The chloride-to-bromide regression method was developed based on west Delta ratios of chloride to bromide that were indicative of sea-water influence, and so for the purposes of this water quality assessment, is considered valid for that area. However, unlike chloride, bromide concentrations in other areas of the Delta may pose environmental risk. Therefore, in areas outside of the west Delta, further assessment was conducted when this method indicated a potential for environmental risk in order to determine if the method was valid or if another method was more appropriate.

Although the regression methods are valid for this water quality assessment where noted above, uncertainty in the results is nonetheless present. The validation studies above describe circumstances in which the model overestimates or underestimates water quality conditions at various locations in the Delta. However, despite this, the methods are still considered valid for comparison purposes as used in this assessment.

This alternative to the mass-balance method for calculating bromide and chloride concentrations in the Delta is limited in the sense that the relationships described above are based on historical water quality data that is representative of historical Delta hydrodynamics. It is unknown whether these relationships will still apply in the future with sea-level rise, and particularly under an altered Delta hydrodynamic regime (as would be expected under the action alternatives). Because each of the two methods have limitations and uncertainty, there is no way to determine which method results in more accurate estimates of chloride or bromide. Thus, where applicable (i.e., for west Delta locations), both methods were applied and the results of both methods discussed. In general, when the methods displayed disagreement, impacts were assessed based on the more conservative of the two methods.

Both the mass-balance and regression methods include assumptions that limit their ability to accurately account for bromide concentrations that would be likely to occur under project implementation. Some of these include:

- Projected sea level rise and climate change (i.e., changes in precipitation patterns and snowpack),
- Inability of the models to account for watershed sources of bromide,
- Assumed footprint and design of restoration areas, and
- Simplifications of restoration area geometry necessary to implement in DSM2.

Calculation of Use of Assimilative Capacity

The concept of assimilative capacity was used as a measure of the extent of water quality degradation that could occur under the alternatives, relative to water quality conditions under the baselines. Water quality degradation was assessed in order to address the Federal and State Antidegradation Policies, which state that existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected (see Section 8.2.1.3 for a full discussion). Assimilative capacity is the capacity of a water body to experience increased levels of a water quality constituent without exceeding the adopted water quality criterion/objective. In practical terms, when levels or concentrations of a water quality constituent are below water quality criteria/objectives, use of available assimilative capacity by an action is the relative amount of water quality degradation that the action causes (i.e., causing an existing constituent concentration to increase such that its resulting concentration is now closer to, but still below the applicable criterion/objective). If the action causes sufficient degradation of water quality such that the resulting constituent level or concentration is now greater than the criterion/objective, then 100% of the available assimilative capacity would be "used" by the action, and thus no assimilative capacity would remain for that constituent.

In this assessment, assimilative capacity available under a baseline was calculated according to equation 2:

$$A_{avail} = C_{WQO} - C_{base} \qquad \textbf{(2)}$$

In the equation above, A_{avail} is the available assimilative capacity, C_{WQO} is the concentration of the water quality objective, and C_{base} is the concentration in the modeled baseline.

The amount of assimilative capacity used by an alternative was calculated according to equation 3:

$$A_{used} = C_{ALT} - C_{base} \qquad \textbf{(3)}$$

In the equation above, A_{used} is the assimilative capacity that was used under the alternative, relative to the baseline, and C_{ALT} is the concentration in the modeled alternative.

The determination of the percent use of available assimilative capacity under an alternative was dependent on the relative values of A_{used} and A_{avail}, and thus was calculated according to equation 4:

$$-\frac{A_{used}}{A_{avail}} \times 100 \quad \text{for} \quad A_{used} \le A_{avail} > 0$$

$$\text{No Calculation} \quad \text{for} \quad A_{avail} \le 0 \qquad \textbf{(4)}$$

$$-100 \quad \text{for} \quad A_{used} \ge A_{avail}$$

In the above equation, the second case in which no calculation was performed occurs when there is no assimilative capacity under the baseline (i.e., concentrations are above water quality objectives), in which case the concept of assimilative capacity is not a useful tool for assessing water quality changes. In the third case, all of the available assimilative capacity is used by the alternative, but the percent use of assimilative capacity is limited to what was initially available (i.e., cannot have greater than 100% use of available assimilative capacity).

Qualitative Assessments

Some constituents were assessed strictly qualitatively (Appendix 8C, *Screening Analysis*, Table SA-11) because: 1) insufficient historical monitoring data were available to adequately characterize the concentrations of the five source waters to the Delta (i.e., to accurately define the distribution of concentrations observed in the SAC, SJR, BAY, eastside tributaries, AGR), which are necessary to implement the quantitative mass-balance assessment approach described above; 2) the locations for which the constituent was assessed (within the affected environment) was outside of any available modeling domain, or available modeling tools were not appropriate for predicting constituent concentrations based on the physical, chemical, and/or biological properties and environmental fate and transport of the constituent. Nevertheless, the same conceptual framework was used for qualitatively assessing constituents of concern. Best available information regarding concentrations/levels in the Delta source waters was evaluated relative to how flow-fractions at various Delta locations would change under the alternatives, as defined by DSM2 model flow-fraction output (Appendix 8D, *Source Water Fingerprinting Results*), to estimate the relative frequency and magnitude of change expected for a given constituent at a specified location.

Additionally, assessments of the effects of implementing CM2–CM21 were qualitative, at a programmatic level, for all constituents. Construction-related water quality changes also were assessed qualitatively. Potential water quality effects of these generally specific and/or geographically localized actions were assessed by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters, and measures to minimize or eliminate adverse construction-related effects on water quality.

8.3.1.4 SWP/CVP Export Service Areas

Assessment of water quality changes in the SWP/CVP Export Service Areas, which begin at the export pumps (i.e., Banks and Jones pumping plants) and extend to facilities receiving exported Delta water, was conducted for construction-related, operations-related, and restoration-related (CM2–CM21) effects.

Water quality changes in the SWP/CVP Export Service Areas were assessed both quantitatively and qualitatively. Water quality changes at the export pumps (i.e., Banks and Jones pumping plants) were quantified using DSM2 for EC and DOC and from mass-balance calculations based on DSM2 flow-fraction output data and Delta source water quality data. Because DSM2 does not account for water sourced from the new north Delta intakes (that are part of all alternatives except Alternative 9), modeled water quality at Banks and Jones pumping plants under the various alternatives was accounted for in post-processing the DSM2 data. For the Existing Conditions, No Action Alternative, and Alternative 9, no post-processing was necessary, since all of the exported water was from the existing south Delta intakes (i.e., “Through-Delta” conveyance). For all “Dual-Conveyance” alternatives (i.e., Alternatives 1A–5, 7, and 8), EC, DOC, and fingerprinting data at the export pumps were blended according to equation 5:

$$\frac{Q_N C_N + Q_S C_S}{Q_N + Q_S} = C_{EXP} \tag{5}$$

In the equation above, Q_N is the flow diverted from the north Delta intakes to either Banks or Jones pumping plants, C_N is the value of the water quality parameter (EC, DOC, or fingerprinting for the 5 source waters) in the Sacramento River at Green's Landing (used as representative of intake water quality), Q_S is the flow exported from the south Delta in either Banks or Jones pumping plants, C_S is the value of the water quality parameter at the existing south Delta intakes for the pumping plants, and C_{EXP} is the value of the water quality parameter in the exported water. For the "Isolated-Conveyance" alternative, Alternative 6, all water quality parameters for the exports at both pumping plants were set equal to the values in the Sacramento River at Green's Landing.

Water quality changes at the export pumps served as the basis for making determinations of water quality changes within the associated primary conveyance facilities, Delta-Mendota Canal and California Aqueduct, as well as the other locations within the service area outside of the Delta, such as San Luis Reservoir and reservoirs operated by southern California water purveyors. Water quality changes in the conveyance and terminus facilities were assessed qualitatively, with consideration of dilution, transformation, uptake, and loss to the extent such factors were applicable to the constituents evaluated.

8.3.1.5 Mercury and Selenium Bioaccumulation Assessment

Mercury and selenium are bioaccumulative constituents of concern in Delta waters. They also are listed as causes of impairment under the Clean Water Act Section 303(d), and a substantial amount is known about their fate and transport within the Delta or similar systems. Consequently, a specific analysis approach was developed for these two constituents.

Mercury and selenium concentrations in surface water were estimated at Delta assessment locations (Figure 8-51) as described previously in Section 8.3.1.3, *Plan Area*. Linkages between abiotic media (sediment and surface water, as applicable) and biological tissues (fish muscle, whole-body fish, and bird eggs) that provide an estimate of the potential bioaccumulation and impacts on ecological and human receptors were evaluated to determine the linkages with the greatest degree of confidence. Potential linkages explored included the following.

- **Literature-based regression models or bioaccumulation factors**. These resources provide a basis for estimating tissue concentrations for mercury and selenium from concentrations in surface water or sediment.
- **Site-specific linkages**. Methods were developed to describe existing relationships between waterborne concentrations of mercury and selenium at the nearest modeling nodes, existing sediment (for mercury), and fish tissue concentrations in an attempt to create predictive relationships for impact analysis and alternatives comparisons.
- **Delta methylmercury**. The TMDL translation equation for mercury (Central Valley Water Quality Board 2011b) was used to estimate fish tissue concentrations from waterborne concentrations. In addition, DSM2 water quality model predictions were investigated separately for their ability to predict measured fish tissue concentrations at discrete locations. The two translation models were compared for their predictive ability.
- **Delta selenium**. U.S. Geological Survey bioaccumulation and trophic transfer factors for uptake of selenium from water to the lowest trophic level (e.g., suspended particulates or algae) and from that level to invertebrates and then to fish and bird eggs developed by Presser and Luoma (2009, 2010a) were used initially to estimate uptake from water to fish and to bird eggs. In calibrating the Delta-wide bioaccumulation model for largemouth bass, the particulate selenium

concentration initially was estimated using a default K_d of 1,000 (K_d = particulate/water ratio; Presser and Luoma 2010a). Because this first step in selenium bioaccumulation typically is much more variable than other steps in the bioaccumulation model, the K_d was then adjusted to calibrate the model so that the modeled concentrations for fish approximated the measured concentrations in bass for normal and wet years (2000 and 2005) and for dry years (2007), as described in Appendix 8M, *Selenium*, Section 8M.4. Initial modeling for fish was based on a model calibrated for largemouth bass as the representative species because of the available data for bass across the Delta. However, because there would be more bioaccumulation of selenium by species such as sturgeon that feed in part on clams that are known to bioaccumulate selenium readily in Suisun Bay, additional modeling was conducted for sturgeon in the western Delta.

Adverse effects on ecological and human receptors were quantified through comparisons of measured and modeled surface water, and tissue (fish [fillets for mercury; whole body and fillets for selenium] and bird eggs [selenium only]) data to established benchmarks, including the following.

- Water quality objectives, criteria, and drinking water standards for mercury, methylmercury, and selenium.
- Literature-derived effect levels for mercury, methylmercury, and selenium in fish fillets for species most representative of the Delta.
- Literature-derived effect levels for selenium in whole-body fish for species most representative of the Delta.
- Literature-derived effect levels for selenium in eggs of bird species most representative of the Delta.
- State of California Office of Environmental Health Hazard Assessment's fish contaminant goals and advisory tissue levels for mercury, methylmercury, and selenium.

The alternatives were evaluated with regard to potential adverse impacts on ecological and human receptors through a weight-of-evidence approach. The Existing Conditions and each alternative were evaluated for their potential to cause exceedances of water quality or tissue benchmarks and for qualitative differences in the spatial extent of those exceedances. Exceedances of tissue benchmarks were determined by evaluating exceedance quotients, which are ratios of the modeled fish or bird egg tissue concentrations divided by the tissue benchmark (e.g., Level of Concern, Toxicity Level, or Advisory Tissue Level) in similar units. Values over 1.0 indicate modeled tissue concentrations exceed the lowest threshold (e.g., Level of Concern for selenium in whole-body fish or in bird eggs) or potentially toxic levels of bioaccumulation (if there is exceedance of the higher Toxicity Level benchmark). The water and tissue concentrations associated with modeled alternatives were compared to modeled Existing Conditions and the No Action Alternative. In addition, spatial changes in the extent of marshlands associated with each alternative (i.e., CM4–CM10) were evaluated qualitatively for their potential to enhance mercury or selenium bioavailability and risk.

8.3.1.6 Summary of Methods Used to Assess Water Quality Changes Related to Construction Activities, Conveyance Facilities Operations and Maintenance, and Habitat Restoration and Other Stressor-Related Conservation Measures/Environmental Commitments

The construction-related water quality changes associated with conveyance facilities and habitat restoration and other stressor-related conservation measures/Environmental Commitments were assessed qualitatively by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying best management/construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters.

Actions associated with new conveyance facilities and operations criteria that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, were assessed quantitatively for all alternatives.

For the BDCP alternatives, restoration actions that would result in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed with operations-related water quality changes of the conveyance facilities operations and maintenance. For Alternatives 4A, 2D, and 5A, the small amount of restoration was not included in the DSM2 modeling. Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively for all alternatives.

Certain conservation measures/Environmental Commitments address other stressors that may affect water quality through reducing contaminants and reducing predators and other sources of direct mortality to listed species. Changes in water quality associated with these other stressor-related conservation measures/Environmental Commitments were assessed qualitatively under a numbered impact separate from the numbered impact addressing effects of facilities operations and maintenance.

Table 8-38 provides a summary of the methodologies used to assess water quality impacts that could result from implementing the alternatives.

1 **Table 8-38. Summary of Methodologies Used for Water Quality Impact Analyses**

Project/Alternative Component	Available Models/ Techniques	Methodology Components		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
Conveyance Facilities Operations and Maintenance	CALSIM II	Hydrologic changes (e.g., seasonal changes in reservoir storage and river flows) used to evaluate dilution effects on constituent levels in reservoirs and rivers.	CALSIM II hydrologic output served as input to the DSM2 model.	Operations of San Luis Reservoir.
	DSM2	NA	EC, DOC concentrations and flow fractions.	EC, DOC concentrations directly modeled at the south Delta export pumps
	Mass Balance Using Flow Fraction and Constituent Concentrations	NA	Estimated concentrations of constituents addressed quantitatively, other than EC and DOC, which are directly modeled by DSM2.	Estimated concentrations of constituents addressed quantitatively, other than EC and DOC, at the south Delta export pumps.
	Qualitative Analysis	All parameters. Qualitative approach determined whether constituent concentrations were correlated to reservoir storage or river flow levels.	For all parameters not addressed quantitatively (see Appendix 8C, Table SA-11). Qualitative approach varied based on constituent of concern and location, but attempted to estimate concentration changes attributable to the alternatives.	For all parameters not addressed quantitatively (see Appendix 8C, Table SA-11). Qualitative approach varied based on constituent of concern, but attempted to estimate concentration changes attributable to the alternatives.

Project/Alternative Component	Available Models/ Techniques	Methodology Components		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
Habitat Restoration Conservation Measures/Environmental Commitments	DSM2	NA	BDCP alternatives: To degree possible, the DSM2 model simulated altered Delta hydrodynamics attributable to restoration tidal and riparian habitats (CM2–CM4). Alternatives 4A, 2D, and 5A: NA	BDCP alternatives: To degree possible, the DSM2 model simulated altered Delta hydrodynamics attributable to restoration tidal and riparian habitats (CM2–CM4). Alternatives 4A, 2D, and 5A: NA
	Qualitative Analysis	NA	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) in specific areas was provided.	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) at the south Delta pumps was provided.
	Qualitative Analysis	NA	Qualitative analysis of how temporary conveyance construction activities would affect water quality (e.g., turbidity, sedimentation) was provided.	Qualitative impact analysis of how conveyance construction activities may affect specific constituent concentrations (e.g., turbidity, nutrients) at the south Delta pumps was provided.
Other Stressor-related Conservation Measures/Environmental Commitments	Qualitative Analysis	NA	Qualitative analysis of how actions would affect water quality was provided.	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.
Construction of Conveyance Facilities and Conservation Measures/Environmental Commitments	Qualitative Analysis	NA	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.

8.3.1.7 Constituent-Specific Considerations Used in the Assessment

Constituent-specific considerations that are common to the assessment of all project alternatives are discussed below. Water quality constituents are also discussed in Section 8.1, *Environmental Setting/Affected Environment*. Data in Section 8.1 is meant to characterize general conditions in the affected environment, and water quality criteria and objectives presented in Section 8.1 are a comprehensive set of all applicable criteria and objectives. In the sections below, the methodology for each constituent assessment is presented, and only historical data and water quality criteria and objectives that are applicable to the assessment are presented. A summary of methods used in the assessments, including the specific methodologies for the quantitative assessments, is shown in Table 8-38.

Construction-Related Water Quality Effects

Water quality effects associated with construction activities for all conservation measures (CM1–CM21) were assessed in a qualitative manner. The potential construction-related water quality effects were assessed considering many aspects of the work involved and potential environmental exposure to contaminants, including, but not limited to the following factors:

- Types of materials and contaminants that may be handled, stored, used, or produced at project facilities during project construction, and which could be released to the environment, and the related fate, transport, and harmful characteristics of the contaminants.
- Magnitude, timing, and duration of the potential contaminant discharges, and exposure sensitivity of water bodies and beneficial uses that could be affected by the discharge.
- Routes of exposure for contaminants, sediment and other constituents from the construction activity causing potential discharges to sensitive water bodies, including likelihood of seasonal exposure to rainfall and runoff, proximity of inland work to drainage ways, occurrence of direct instream discharges, and whether exposure would involve long-term effects of tidal flow in the estuary.

The assessment of potential water quality effects considered all of the beneficial uses. However, given the generally temporary and intermittent characteristics of construction and maintenance discharges, a focus of the assessment is on effects to aquatic life as the likely most sensitive beneficial uses in the receiving water (also refer to Chapter 11, *Fish and Aquatic Resources*, for additional discussion of the effects of construction). In particular, large or sudden increases in sediment, or contaminant concentrations in sediment from construction or operations/maintenance activities are most likely to affect short-term, sensitive water quality characteristics such as acute health responses of aquatic organisms and their habitats. Other beneficial uses, such as municipal/industrial water supplies, recreational activities, or livestock/agricultural irrigation, are generally anticipated to be less sensitive to short-term water quality disturbances.

Ammonia

For the purposes of this analysis, the U.S. EPA's 1999 National Recommended Water Quality Criteria for ammonia and the 2009 draft criteria were used. U.S. EPA's 2009 draft recommended criteria are more restrictive than its 1999 recommended criteria. Values derived for water at 25 °C and pH 8 are shown in Table 8-39, and were used as the reasonable worst case (i.e., most sensitive) criteria in the affected environment. The chronic criteria derived according to the 2009 draft documentation (0.26

mg/L-N) is also lower than the LOEL of 0.36 mg/L-N for chronic effects recently derived to *P. forbesi*, a copepod within the affected environment (Teh et al. 2011:2).

A final relevant threshold includes a recommended goal for sensitive crops of 1.5 mg/L-N (Ayers and Westcot 1994). It is assumed that ammonia is beneficial for crops at levels below this threshold, and thus that any increases in ammonia-N concentrations that are below the 1.5 mg/L-N threshold are generally not of concern for agriculture.

Table 8-39. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Ammonia (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plan[a]	California Toxics Rule	Drinking Water MCL	U.S. EPA Recommended Criteria	Other Relevant Thresholds
Ammonia-N	–	25	–	–	5.6/1.2 (1999)[b] 2.9/0.26 (2009)[c]	1.5[d], 0.36[e]

Notes: MCL = maximum contaminant level; mg/L = milligrams per liter.

[a] San Francisco Bay Regional Water Quality Control Board 2007. 25 mg/L 4-day average for ammonia-N.

[b] First value represents acute, salmon present, second value represents chronic, fish early life stage s present, for water temperature 25 °C and pH 8.

[c] First value represents acute, freshwater mussels present, second value represents chronic, freshwater mussels present, for water temperature 25 °C and pH 8.

[d] Ayers and Westcot (1994). Recommended goals for sensitive crops

[e] Lowest Observed Effect Level (LOEL) determined in Teh et al. 2011, for chronic effects on *P. forbesi*.

Figure 8-52 shows the seasonal levels of ammonia in the three major source waters to the Delta—SAC, SJR, and BAY. The data indicate that SJR and BAY concentrations are similar during all months of the year. SAC concentrations are greater than BAY or SJR virtually all of the time, being more similar in January through March and much greater during the rest of the year. The high concentrations of ammonia in SAC are a result of the SRWTP, which discharges into the Sacramento River at Freeport. Ammonia concentrations upstream of the SRWTP are similar to those in BAY and SJR (Central Valley Regional Water Quality Control Board 2010a:5). Thus, the primary way in which project alternatives could affect ammonia concentrations is by altering flows in the Sacramento River at Freeport, which would alter available dilution for ammonia from the SRWTP. Consequently, the assessment of ammonia in the Plan Area focused on the changes in flows in the Sacramento River at Freeport and the subsequent effects on dilution and ammonia concentrations downstream.

The SRWTP NPDES permit was renewed by the Central Valley Water Board on December 20, 2010. The permit contains seasonal effluent limitations for ammonia-N of 1.5 mg/L on an average monthly basis and 2.0 mg/L on a maximum daily basis for the months April through October, and of 2.4 mg/L on an average monthly basis and 3.3 mg/L on a maximum daily basis for the months November through March (Central Valley Regional Water Quality Control Board 2010b:14), that must be achieved by May of 2021. In order to meet these limits, the SRWTP must be upgraded to include nitrification. For the purposes of this assessment, assumptions were made regarding the status of the upgrades under the various baselines, alternatives, and time-steps, and these are summarized in Table 8-40.

Table 8-40. Assumptions on Status of Sacramento Regional Wastewater Treatment Plant Nitrification Upgrades under Assessment Scenarios

Scenario	Status of Upgrades	Average Monthly Effluent Limit for Ammonia, mg/L as N
Existing Conditions	No Upgrades	33
No Action Alternative (2060)	Upgrades Complete	1.5 (Apr–Oct) 2.4 (Nov–Mar)
Alternatives 1A–9 (2060)	Upgrades Complete	1.5 (Apr–Oct) 2.4 (Nov–Mar)

Note: mg/L = milligrams per liter.

Boron

Applicable boron objectives for the affected environment utilized in this assessment are summarized in (Table 8-41).

Table 8-41. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Boron

	Region 5 Basin Plan[a]	Region 2 Basin Plan	USEPA Recommended Criteria
Boron (µg/L)	800/2000[b] 1,000/2,600[c] 1,300[d]	500/2,000[e] 5,000[f]	2,000/5,000[g]

[a] Basin Plan objectives apply to the lower San Joaquin River from the mouth of the Merced River to Vernalis (Central Valley Regional Water Quality Control Board 2009a).

[b] Agricultural objective for March 15 through September 15 specified as (monthly average) / (maximum) concentration (except critical water years).

[c] Agricultural objective for September 16 through March 14 specified as (monthly average) / (maximum) concentration (except critical water years).

[d] Agricultural objective applicable year-round as a monthly average for critical water years.

[e] Basin Plan agricultural objectives specified for irrigation as (threshold concentration) / (limit concentration) (San Francisco Bay Regional Water Quality Control Board 2007).

[f] Basin Plan agricultural objective specified for stock watering (San Francisco Bay Water Board 2007).

[g] Recommended human health advisory levels for long-term exposure through drinking water supplies specified in the form of (children)/(adults) (U.S. Environmental Protection Agency 2008b).

Sources of boron to Delta waters include the Sacramento River, the San Joaquin River, the Eastside tributaries, Delta agricultural return drains, and the San Francisco Bay. Among these sources, San Francisco Bay water contains the highest boron concentrations, followed by Delta agricultural returns, the San Joaquin River, the Sacramento River, and the Eastside tributaries (Table 8-42). Point source discharges containing boron contribute a small fraction of the boron burden to the lower San Joaquin River (Central Valley Regional Water Quality Control Board 2009a).

The lower San Joaquin River is listed on the State's CWA Section 303(d) list of impaired water bodies for salt and boron (State Water Resources Control Board 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Water Board has prepared a TMDL with implementation program where it is assumed that actions taken to control salts also will control for boron as well (Central Valley Regional Water Quality Control Board 2004).

Table 8-42. Historical Boron Concentrations in the Five Delta Source Waters

	Source Water				
Data Parameters	Sacramento River	San Joaquin River	San Francisco Bay[a]	East Side Tributaries	Delta Agriculture Return Waters[b]
Mean micrograms per liter (µg/L)	100	349	880	68	492
Minimum (µg/L)	100	100	–	10	103
Maximum (µg/L)	200	1,100	–	250	1,192
75th Percentile (µg/L)	100	400	–	100	584
99th Percentile (µg/L)	100	918	–	244	1,159
Data source	DWR	DWR	Paulsen and List (1997) and DWR	USGS	DWR
Station(s)	Sacramento River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	Martinez and Sacramento River at Mallard Island	Cosumnes River	–[b]
Date range	1986–2009	1986–2009	1986–2009	1953–1977	1987–2001
ND replaced with RL[c]	Yes	No	No	Yes	Yes
Data omitted	Two data points assumed to be in error (1,900 µg/L, 1,000 µg/L)	None	None	None	None
No. of Data Points	468	483	265	60	339

[a] No data available for boron at Martinez in any of the available data sets. Paulsen and List (1997) measured boron daily at Martinez from 4/13/96–8/29/96. Paulsen and List (1997) lists only the mean, minimum, and maximum concentrations found. However, extensive boron data was available for the Sacramento River at Mallard Island (i.e., DWR MWQI program data for 1986–2009) which indicated a strong seasonal concentration pattern in the western Delta. Consequently, to estimate the seasonal monthly average boron concentrations at Martinez, the monthly average mean values for Mallard Island were multiplied by the ratio of the average Martinez (Paulsen and List 1997) to long term average Mallard Island mean concentrations. Refer to Appendix 8F, Table Bo-1, for additional information and tabulation of the calculated monthly average boron concentrations for the Bay source water.

[b] Agricultural return drains are distributed unevenly throughout the Delta. Water quality associated with these drains varies depending on the specific location of the drain within the Delta, and largely coincides with the water quality of the water that is withdrawn from the Delta for application onto agricultural lands. In order to characterize boron concentrations in agricultural drain water as a whole, the following process was followed:

All boron data from those agricultural drains from the DWR Water Data Library, which had historical boron data, were placed into a database.

The drains were assigned a region in the Delta according to their location (Central, North, East, South, and West)

Three drains from each region were chosen at random, and the data from each of these drains was downloaded.

The stations selected included: Ag Drain on Jersey Island, Ag Drain on King Island, Pumping Plant (PP.) No. 1, Ag Drain on King Island, PP. No. 2, Ag Drain on Orwood Tract, Ag Drain on Palm Tract, Ag Drain on Pescadero Tract, PP. No. 3, Ag Drain on Pescadero Tract, PP. No. 4, Ag Drain on Rindge Tract, PP. No. 1, Ag Drain on Twitchell Island., PP. No. 1, Ag Drain on Pescadero Tract, PP. No. 1

To derive an overall mean, minimum, maximum, 75th, and 95th percentile, the mean, minimum, maximum, 75th and 95th percentiles of the individual drain averages was calculated.

The process was an attempt to derive values that were representative of the Delta as a whole, regardless of how many drains in each region had data, and how many data points existed at each drain.

[c] In some cases, data were reported as non-detections (ND), and the entry contained an accompanying reporting limit (RL). "Yes" indicates that at least one non-detection was replaced with the reporting limit in order to calculate summary statistics, while "No" indicates that this was not done, generally because no data were reported as non-detection.

Because of boron's elemental nature, it is considered a conservative constituent, not subject to degradation through volatilization, breakdown, or uptake as it moves through the system. Boron, however, does adsorb to mineral soils and organic matter, which allows for its accumulation in soils irrigated with water containing boron. Because of its ability to leach through soils, this partitioning can be considered temporary; therefore, the assessment of potential impacts from boron assumes that mass is generally conserved. Consequently, boron concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate boron concentration changes that would occur with the alternatives. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the boron concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location. Additionally, sample data for boron at the Martinez location were limited to literature values for the annual average concentration, whereas substantial monthly data were available for the Sacramento River at Mallard Island. Consequently, monthly average Martinez concentrations were estimated by simple linear extrapolation of the monthly average Mallard Island concentrations by the ratio of the annual average Mallard Island to Martinez concentration.

The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to boron, and contribution to 303(d) impairment effects). The assessment of effects relative to applicable objectives/criteria for the protection of agricultural beneficial uses was based on changes in monthly average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991), and the effects relative to municipal and industrial water supply was based on changes in annual average concentrations for the modeled 16-year and drought periods.

The implementation of CM4 would restore substantial areas of tidal habitat that is expected to increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a substantial source of boron, thus, the increased tidal exchange resulting from tidal habitat restoration may increase boron concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased boron concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on boron concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM21) which do not substantially affect flows or Delta hydrodynamic conditions, also were assessed qualitatively.

Bromide

Bromide concentrations at a particular location and time in the Delta are determined primarily by the sources of water to that location, at a given time. Hence, long-term average concentrations at a particular Delta location are determined primarily by the long-term average sources of water to that location, and the long-term average concentration of bromide in each of the major source waters to the location. The major source waters to any given Delta location are: (1) Sacramento River, (2) San Joaquin River, (3) Bay water, (4) eastside tributaries, and (5) agricultural return water.

Bromide is not routinely monitored in surface water samples collected north of the Delta, primarily due to the low concentration of bromide in this region. Data available for the American River suggests that bromide concentrations are <10 μg/L. Table 8-43 provides a summary of bromide concentrations in the primary source waters of the Delta, as well as information on the source of the data and summary statistics. Due to the quality and quantity of data available, as well as the conservative nature of the constituent, a quantitative assessment utilizing a mass-balance approach was employed in the assessment of alternatives. Additionally, results of a second modeling approach utilizing EC to chloride and chloride to bromide relationships were used to supplement the results of the mass-balance approach (see Section 8.3.1.3, *Plan Area*). Because bromide is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average bromide concentrations at various locations throughout the affected environment. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No.1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Buckley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, bromide concentrations for water transported into the SWP/CVP Export Service Areas are assessed based on concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants).

As demonstrated in Table 8-43, achieving the CALFED goal of 50 μg/L bromide at drinking water intakes is challenged by the bromide concentrations in two main source waters to the Delta, the San Joaquin River and San Francisco Bay (seawater), where long-term average concentrations exceed this goal many fold. In establishing its source water goal for bromide, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with bromide between 100 μg/L and 300 μg/L is believed sufficient to meet currently established drinking water criteria for DBPs, depending on the amount of *Giardia* inactivation required (California Urban Water Agencies 1998, ES2). This assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future bromide concentrations would exceed 50 μg/L (based directly on the CALFED goal) and 100 μg/L (based on the lower limit of the range considered sufficient for meeting currently established drinking water criteria) on a long-term average basis at the assessment locations. Because, in many cases, existing bromide concentrations in Delta water bodies already exceed 50 μg/L, the focus of the assessment is on the frequency with which bromide would exceed 100 μg/L, as well as the change in long-term average bromide concentration.

As described in Section 8.3.1.3, *Plan Area*, there are uncertainties present in the two modeling approaches used to estimate bromide concentrations that would occur under the action alternatives. Regardless of whether the modeling may have overestimated or underestimated bromide concentrations that would occur under the alternatives, the modeling results allow for making determinations of whether concentrations would increase or decrease under a particular alternative, by comparing the modeled concentrations under the alternative to concentrations modeled for Existing Conditions and the No Action Alternative. 4Thus, for bromide, the magnitude of change in long-term average bromide concentrations in addition to the comparison of exceedance of the 100 μg/L threshold served as the basis for the impact determinations in the EIR/EIS. Because 100 μg/L is at the low end of the range of concentrations considered sufficient to meet current drinking water criteria for DBPs, the assessment is conservative relative to potential impacts on drinking water treatment facilities.

The modeling relies on several assumptions that could have large impacts on the predicted level of seawater intrusion. The two most major assumptions are: 1) the assumed level of sea level rise and 2) the assumed restoration area footprints used in the modeling. Changes in either of these assumptions would likely affect predicted bromide concentrations at Barker Slough. Additionally, DSM2 is known to not account well for local diversions and returns in the Barker Slough area, and the assumed modeled pumping schedule for the Barker Slough Pumping Plant may not accurately reflect actual operations. Local diversions and returns, as well as the pumping schedule, can affect Barker Slough hydrodynamics, but it is unknown whether these factors would play a major role in Barker Slough bromide concentrations under the alternatives.

Table 8-43. Source Water Concentrations for Dissolved Bromide (µg/L)

Source Water	Sacramento River	San Joaquin River	San Francisco Bay[a]	Eastside Tributaries	Agriculture in the Delta
Mean micrograms per liter (µg/L)	15	251	13,149–32,951	16	456
Minimum (µg/L)	1	20	28–17,465	14	20
Maximum (µg/L)	100	650	33,985–44,100	17	2,720
75^{th} Percentile (µg/L)	20	345	22,313–38,500	NA	580
99^{th} Percentile (µg/L)	44	565	22,313–38,500	NA	1,850
Data Source	DWR	DWR	BDAT	BDAT	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	[b]	Mokelumne River at Sacramento Road	[c]
Date Range	1990–2009	1990–2009	1980–2007	1990–1990	1990–2001
Non-Detections Replaced with Reporting Limit	Yes	No	No	No	No
Data Omitted	None	None	None	None	Yes[d]
No. of Data Points	560	547	26–27	2	991

Notes: BDAT = Bay Delta and Tributaries Project; DWR = California Department of Water Resources.

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average bromide at Martinez suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at this location, average monthly concentration was used. Actual monthly values for the dataset are provided in Appendix 8E, *Bromide*, Table 1.

[b] Measured bromide data at Martinez was not available for this analysis. Bromide data at Martinez was estimated from the regressed relationship of bromide to chloride at Mallard Island (Appendix 8E, *Bromide*, Figure 1). The empirical relationship of bromide to chloride obtained at Mallard Island was similar to that of ocean water (Morris and Riley 1966), or 0.0035 parts bromide to 1 part chloride. Bromide data at Martinez used in this analysis therefore represents measured Martinez chloride multiplied by a factor of 0.0035.

[c] Values calculated from all agriculture drain data pooled together. All bromide data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average bromide varied by less than a factor of 3, with highest concentration in the southern Delta and lowest in the central Delta. No bromide data was available for the northern Delta. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

[d] Data for the Byron Tract #2 and Byron Tract #3 agricultural drains were omitted from the database due to their reported values being substantially outside the distribution of all other values. These values were: 65,000 µg/L and 46,800 µg/L. In total, 2 data points were omitted and 991 were retained.

Chloride

As an inorganic anion, chloride is generally conservative in the aquatic environment and its fate and transport characteristics are similar to other salinity constituents. Consequently, chloride concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate chloride concentration changes that would occur as a result of implementation of the project alternatives.

In addition, under Alternatives 1A–C, 2A–C, 3, 4, 5, 6A–C, 7, 8, and 9, the implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a major source of chloride, thus, the increased tidal exchange resulting from tidal habitat restoration may increase chloride concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling for these alternatives included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased chloride concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on chloride concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction.

The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM21) under Alternatives 1A–C, 2A–C, 3, 4, 5, 6A–C, 7, 8, and 9, and Environmental Commitments under Alternatives 4A, 2D, and 5A, which do not substantially affect flows or Delta hydrodynamic conditions, were assessed qualitatively.

Applicable chloride objectives for the affected environment utilized in this assessment are summarized in Table 8-44. The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to chloride) based on averaging periods appropriate for each relevant beneficial use. Results of a second modeling approach utilizing relationships between EC and chloride were used to supplement those results (see Section 8.3.1.3, *Plan Area*). The assessment of effects relative to designated beneficial uses and associated water quality objectives/criteria was based on changes in long-term average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991). Compliance for some applicable objectives/criteria are based on short-term averaging period concentrations; e.g., daily data for Bay-Delta WQCP objectives for municipal and industrial water supply for specific locations in the Delta (e.g., daily data). The available monitoring data for source water chloride concentrations are not adequate to characterize daily variability, and the channel flows modeled in CALSIM, which provides the hydrologic input to the DSM2 model, are on a monthly time-step. Therefore, the mass-balance approach can only be used for monthly average assessment, and thus for the chloride assessment cannot be used to evaluate exceedances of the 150 mg/L objective, and can only evaluate exceedances of the 250 mg/L objective on a monthly average basis instead of a daily average basis. Consequently, the assessment of potential effects of alternatives relative to the 150 mg/L objective was based only on daily chloride data obtained via the EC to chloride relationships and DSM2 EC output (as described in Section 8.3.1.3). Relative to the 250 mg/L objective, assessment was based on both monthly average concentrations from the mass-balance approach and daily average concentrations from the EC to chloride relationship approach.

Understanding the uncertainties and limitations in the modeling and assessment approach is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. Please refer to Section 8.3.1.1, *Models Used and Their Linkages*, and Section 8.3.1.3, *Plan Area*, for a description of these limitations. In light of these limitations, the assessment of compliance is conducted in terms of assessing the overall direction and degree to which Delta chloride would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta chloride to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode. The fact that modeling shows potential violations does not mean that under real time operations such violations would actually occur in the real world.

The U.S. EPA has also published recommended national aquatic life criteria for chloride (Table 8-44). This recommended chloride criterion is not used in the assessment of Delta effects for several reasons. Firstly, the U.S. EPA recommended chloride criterion is only applicable to freshwater, and its appropriate application in a dynamic estuary such as the Delta is uncertain. Secondly, the national recommended criterion is currently being revised by U.S. EPA. New toxicity studies have resulted in a different understanding of species sensitivities in freshwater, and have revealed a hardness and sulfate dependence (i.e., similar to that of trace metals) that was not taken into consideration in the drafting of the most current criterion. Thirdly, with regard to aquatic life beneficial uses in the Delta, the State has taken the approach of regulating salinity through the establishment of EC objectives. Chloride is a major component of salinity, as measured by EC. Effects on compliance with EC-related aquatic life objectives is addressed for each project alternative relative to model predicted changes in Delta EC. In addition, salinity-based project alternative effects to covered and uncovered fish species, invasive benthic invertebrates, invasive aquatic vegetation, and cyanobacteria (blue-green algae) are addressed in Chapter 11, *Fish and Aquatic Resources*.

Table 8-44. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Chloride (mg/L unless specified)

Location	Bay-Delta Water Quality Control Plan		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL	U.S. EPA Recommended Criteria
All Receiving Waters Other Than the Delta	- -		250[a, b] 500[a, c] 600[a, d]	142/355[e] 250[a, b] 500[a, c] 600[a, d]	250[b] 500[c] 600[d]	230/860[f]
Delta-Specific						
Contra Costa Canal @ Pumping Plant No. 1 or San Joaquin River @ Antioch Water Works Intake	Year Type	Objective[g]	- -	- -	- -	- -
	W	<150–240 days/calendar year (66%)				
	AN	<150–190 days/calendar year (52%)				
	BN	<150–175 days/calendar year (48%)				
	D	<150–165 days/calendar year (45%)				
	C	<150–155 days/calendar year (42%)				
Contra Costa Canal @ Pumping Plant #1, West Canal @ Mouth of Clifton Court Forebay, Jones Pumping Plant, Barker Slough @ North Bay Aqueduct, and Cache Slough @ the City of Vallejo Intake	250 (Oct.–Sep.)[h]		- -	- -	- -	- -

Notes: Water year types: W = wet; AN = above normal; BN = below normal; D = dry; C = critical. mg/L = milligrams per liter.

[a] State secondary maximum contaminant level (MCL) incorporated by reference in the Basin Plan. No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level for the state secondary MCL. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply identified in Basin Plan as a "threshold value/limit value"; no averaging period is defined for assessment of compliance.

[f] U.S. EPA National Recommended Water Quality Criteria specified as Criterion Continuous Concentration (CCC)/Criteria Maximum Concentration (CMC).

[g] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value for at least the number of days shown during the calendar year. Must be provided in intervals of not less than two weeks duration (percentage of calendar year shown in parentheses).

[h] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value to be applied year-round for all water year types.

Table 8-45 provides a summary of chloride concentrations in the primary source waters of the Delta used for the mass-balance approach, as well as information on the source of the data and summary statistics. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the chloride concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location.

Table 8-45. Historical Chloride (Dissolved) Concentrations in the Five Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay[a]	East Side Tributaries	Delta Agriculture Return Waters[b]
Mean (mg/L)	6.38	81.4	3,757–9,414	2.36	136
Minimum (mg/L)	1.00	1.00	8–4,990	0.30	3.0
Maximum (mg/L)	33.0	221	9,710–12,600	8.60	830
75th Percentile (mg/L)	8.00	111	6,375–11,000	3.05	175
99th Percentile (mg/L)	12.3	186	9,643–1,2574	5.79	636
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River, Cosumnes River	[b]
Date Range	1980–2009	1980–2009	1980–2007	1952–1994	1987–2001
ND Replaced with RL	No	No	No	No	No
Data Omitted	None	None	None	Single <0.1 value from each data set, 0 values from Cosumnes River	None
No. of Data Points	867	844	26–27	391	1,543

Notes: BDAT = Bay Delta and Tributaries Project; DWR = California Department of Water Resources; mg/l = milligrams per liter; ND = non-detections; RL = reporting limit; USGS = U.S. Geological Survey.

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Review of available sample data for the Martinez location suggests that there is a generally seasonal trend in monthly average chloride concentration.

Chloride concentrations used to represent San Francisco Bay water in the mass-balance assessment were determined on a monthly average basis. Refer to Appendix 8G, Table Cl-61, for additional information and tabulation of the calculated monthly average chloride concentrations for the Bay source water.

[b] Values calculated from all agriculture drain data pooled together. All chloride data from agricultural drains contained in the DWR Water Data Library were placed into a single database.

Seasonal or long-term changes in chloride concentrations at western Delta locations would be associated with changes in the location of the tidal mixing zone and interface of the elevated Bay salt water and freshwater Delta outflow. Changes in the salt water/freshwater interface may result in shifts of the acceptability of a location between freshwater- and salinity-tolerant aquatic fish, aquatic vegetation, and other aquatic organisms. The significance of these potential effects relative to applicable freshwater and estuarine water quality objectives is not assessed in the chloride assessment. Rather, the reader is referred to Chapter 11, *Fish and Aquatic Resources*, for the detailed assessment of changes in the location of the tidal mixing zone (e.g., as measured by the location of X2) and for its impact(s) to aquatic life beneficial uses.

Dissolved Oxygen

DO levels in the reservoirs and rivers upstream of the Delta are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

Effects of the alternatives on temperature in the Delta relative to the No Action alternative were not considered in the DO assessment. This is because, as stated in the USFWS (2008b:194) Operations Criteria and Plan BiOp:

> The [state and federal] water projects have little if any ability to affect water temperatures in the Estuary (Kimmerer 2004). Estuarine and Delta water temperatures are driven by air temperature. Water temperatures at Freeport can be cooled up to about 3°C by high Sacramento River flows, but only by very high river flows that cannot be sustained by the projects. Note also that the cooling effect of the Sacramento River is not visible in data from the west Delta at Antioch (Kimmerer 2004) so the area of influence is limited.

Since Delta water temperatures are driven by air temperature, climate change (as included in the No Action Alternative and all action alternatives) that increases air temperatures relative to existing conditions would be expected to increase water temperatures in the Delta as well. Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In general, waters of the Delta would be expected to warm less than 5 degrees F, which translates into a < 0.5 mg/L decrease in DO.

The DO assessments were conducted in a qualitative manner based on anticipated changes in these factors.

Additionally, concerns have been raised that the project may increase flows on the San Joaquin River at Stockton, causing the location of the minimum DO point to shift downstream (see Section 8.1.3.6, *Dissolved Oxygen*, for a discussion of the existing DO impairment in the Stockton Deep Water Ship Channel). To assess this possibility, flows in San Joaquin River at Stockton were evaluated.

Electrical Conductivity

EC and TDS values tend to be highly correlated, because the majority of chemicals that contribute to TDS are charged particles that impart conductance of water. Because EC measurement is easily conducted with a portable meter, as compared to the requirement for physical sample collection and laboratory gravimetric analysis for TDS, the majority of water quality regulatory criteria/objectives are established for EC. Moreover, where regulatory objectives for TDS exist, they co-occur with the equivalent EC value (i.e., there are no independent TDS-only regulatory criteria/objectives or guidance values). EC also is the parameter modeled to represent salinity in DSM2. Therefore, this impact assessment for "salinity" as indicated by EC and TDS is based on EC values only and TDS is not addressed separately.

Applicable EC objectives for the affected environment utilized in this assessment are summarized in Table 8-46.

Table 8-46. Applicable State Objectives and Other Relevant Effects Thresholds for Electrical Conductivity (µmhos/cm[at 25°C] unless specified)

Location	Bay-Delta Water Quality Control Plan		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
All Receiving Waters Other than the Delta	- -		900[a, b] 1,600[a, c] 2,200[a, d]	200–3,000[e] 900[f]	900[a, b] 1,600[a, c] 2,200[a, d]
Delta-Specific	Year Type	Objective[g] for Agricultural Beneficial Uses			
Western Delta–Sacramento River at Emmaton	Wet (W)	450 (Apr. 1–Aug. 15)	- -	- -	- -
	Above Normal (AN)	450 (Apr. 1–Jun. 30); 630 (Jul. 1–Aug 15)			
	Below Normal (BN)	450 (Apr. 1–Jun. 19); 1,140 (Jun. 20–Aug 15)			
	Dry (D)	450 (Apr. 1–Jun. 14); 1,670 (Jun. 15–Aug 15)			
	Critical (C)	2,780 (Apr. 1–Aug. 15)			
Western Delta–San Joaquin River at Jersey Point	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Jun. 19); 740 (Jun. 20–Aug 15)			
	D	450 (Apr. 1–Jun. 14); 1,350 (Jun. 15–Aug 15)			
	C	2,200 (Apr. 1–Aug. 15)			
Interior Delta–South Fork Mokelumne River at Terminous	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Aug. 15)			
	C	540 (Apr. 1–Aug. 15)			
Interior Delta–San Joaquin River at San Andreas Landing	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Jun. 24); 580 (Jun. 25–Aug 15)			
	C	870 (Apr. 1–Aug. 15)			

Location	Bay-Delta Water Quality Control Plan				Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
Southern Delta	Objective for Agricultural Beneficial Uses				- -	- -	-
	700 (Apr. 1–Aug. 31)						
	1,000 (Sep. 1–Mar. 31)[h]						
Export Area	Objective for Agricultural Beneficial Uses				- -	- -	- -
	1,000 (Oct. 1–Sep. 30)[i]						
San Joaquin River at and between Prisoners Point and Jersey Point	Objective for Fish and Wildlife Beneficial Uses				- -	- -	- -
	440 (Apr. 1–May 31)[j]						
Eastern Suisun Marsh (Sacramento River at Collinsville; Montezuma Slough at National Steel; Montezuma Slough near Beldon's Landing)	Month	Objective[k] for Fish and Wildlife Beneficial Uses			- -	- -	- -
	Oct	19,000					
	Nov–Dec	15,500					
	Jan	12,500					
	Feb–Mar	8,000					
	Apr–May	11,000					
Western Suisun Marsh (Chadbourne Slough at Sunrise Duck Club, Suisun Slough [300 feet south of Volanti Slough], Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Island Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Island)	Month	Objective[l]	Month	Objective[m] for Fish and Wildlife Beneficial Uses	- -	- -	- -
	Oct	19,000	Oct	19,000			
	Nov	16,500	Nov	16,500			
	Dec	15,500	Dec–Mar	15,600			
	Jan	12,500	Apr	14,000			
	Feb–Mar	8,000	May	12,500			
	Apr–May	11,000					

Notes for Table 8-46

[a] State secondary maximum contaminant level (MCL). No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply specified as a "limit" consisting of a range of concentrations and no averaging period is defined for assessment of compliance.

[f] Objective for municipal supply.

[g] Agricultural objective is a 14-day running average of mean daily electrical conductivity (EC).

[h] Agricultural objective is a maximum 30-day running average of mean daily EC. Objectives applicable to all southern Delta channels and specified compliance stations (i.e., San Joaquin River at Airport Way Bridge-Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge).

[i] Agricultural objective is a maximum monthly average of mean daily EC. Compliance stations are West Canal at Mouth of Clifton Court Forebay and Delta-Mendota Canal at Tracy Pumping Plant.

[j] Fish and wildlife objective is a maximum 14-day running average of mean daily EC.

[k] Fish and wildlife objectives for Sacramento at Collinsville, Montezuma Slough at National Steel, and Montezuma Slough near Beldon's Landing. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[l] Fish and wildlife objectives for Chadbourne Slough at Sunrise Duck Club, Suisun Slough (300 feet south of Volanti Slough), Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Island Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Island. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[m] A deficiency period is: (1) the second consecutive dry water year following a critical year; (2) a dry water year following a year in which the Sacramento River Index (described in footnote e) was less than 11.35; or (3) a critical water year following a dry or critical water year. The determination of a deficiency period is made using the prior year's final Water Year Type determination and a forecast of the current year's Water Year Type; and remains in effect until a subsequent water year is other than a Dry or Critical water year as announced on May 31 by the California Department of Water Resources and U.S. Bureau of Reclamation as the final water year determination.

The assessment of effects on EC in the reservoirs and rivers upstream of the Delta was qualitative, and evaluates changes in EC based on anticipated changes in EC-contributing sources in the watersheds under the various project alternatives assessed.

The assessment of hydrodynamic effects of the project alternatives operations on EC in the Plan Area relied on DSM2 output. Because under Alternatives 1A–C, 2A–C, 3, 4, 5, 6A–C, 7, 8, and 9 implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels, the DSM2 modeling for these alternatives included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions.

The effects of other conservation measures (i.e., CM3 and CM5–CM21) under Alternatives 1A–C, 2A–C, 3, 4, 5, 6A–C, 7, 8, and 9, and Environmental Commitments under Alternatives 4A, 2D, and 5A, which do not substantially affect Delta hydrodynamic conditions, were assessed qualitatively.

DSM2 directly models Delta EC levels on a 15-minute interval. DSM2 output for EC was post-processed to compare results to the Bay-Delta WQCP objectives at the following locations.

- Western Delta: Sacramento River at Emmaton and San Joaquin River at Jersey Point
- Interior Delta: South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing, and San Joaquin River at Prisoners Point
- Southern Delta: San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge

For the assessment of Alternatives 1A–3 and 5–9, the Sacramento River at Emmaton compliance location is relocated to Threemile Slough near the Sacramento River. For comparing effects of the alternatives on EC in this portion of the Delta, two comparisons were made.

- Changes in EC in the Sacramento River at Emmaton under the alternatives are compared to EC at Emmaton under Existing Conditions and the No Action Alternative.
- Changes in EC in Threemile Slough under the alternatives are compared to EC at Emmaton under Existing Conditions and the No Action Alternative.

Alternative 4 does not include a change in compliance point from Emmaton to Threemile Slough. However, modeling was originally performed for Alternative 4 assuming the compliance point did shift from Emmaton to Threemile Slough. To understand the impact of maintaining the compliance point at Emmaton under Alternative 4, sensitivity analysis model runs were performed. These are discussed in the assessment of Alternative 4 to contextualize Alternative 4 results.

The western and interior Delta EC objectives are expressed as a 14-day running average, and the southern Delta EC objectives are expressed as a 30-day running average. Compliance with these EC objectives was assessed by calculating 14-day and 30-day running averages of the 15-minute DSM2 EC results and tallying the number of days out of compliance with the applicable objective. The Bay-Delta WQCP considers all days in an averaging period out of compliance, if the objective is exceeded on the last day of the averaging period. Because this could overestimate the general change in EC at compliance locations, the number of days the running average EC objective was exceeded was also assessed to identify general trends in EC changes under the alternatives assessed.

Some of the EC objectives are dependent on water year type. It must be noted that 3 of the 16 water years in the simulation change in the late long term, as compared to Existing Conditions, as a result of climate change. For each year of the DSM2 simulation for each scenario, the water year type that was used to define the objective was the water year type for the time step of interest. Thus, for the late long-term scenarios, compliance was based on the objective defined according to the late long term water year types, and for Existing Conditions compliance was based on the objective defined according to the Existing Conditions water year types.

The effects on EC in SWP/CVP Export Service Areas also relied on DSM2 output. For assessment of alternatives involving conveyance of north Delta water to the Banks and Jones pumping plants, DSM2 results for the south Delta pumping plant locations were blended, or mass-balanced, with modeled north Delta diversions to provide an estimate of the EC of the water conveyed by these pumping plants to the SWP/CVP Export Service Areas south of the Delta. The resulting blended monthly mean EC levels were compared to the Bay-Delta WQCP objectives for the export areas, which are the objectives for protection of the agricultural beneficial uses in the south Delta SWP/CVP Export Service Areas.

Assessment of Suisun Marsh EC was conducted qualitatively, utilizing average EC for the entire period modeled (1976–1991) to determine the overall change and degree to which EC could be affected by the alternatives. The Suisun Marsh locations utilized in the analysis correspond to the EC compliance locations in the Bay-Delta WQCP: Sacramento River at Collinsville, Montezuma Slough at National Steel, Montezuma Slough near Beldon's Landing, Chadbourne Slough at Sunrise Duck Club, and Suisun Slough 300 feet south of Volanti Slough. These locations represent a geographic range from which to assess changes.

The assessment of Bay-Delta WQCP EC objectives showed exceedances of these objectives at several locations under Existing Conditions, No Action, and project alternatives. Understanding the uncertainties and limitations in the modeling and assessment approach is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. Please refer to Section 8.3.1.1, *Models Used and Their Linkages*, and Section 8.3.1.3, *Plan Area*, for a description of these limitations. In light of these limitations, the assessment of compliance is conducted in terms of assessing the overall direction and degree to which Delta EC would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta EC to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode.

Furthermore, there are several factors related to the modeling approach that may result in modeling artifacts that show objective exceedance, when in reality no such exceedance would occur. Sensitivity analyses and further other analyses were performed to evaluate whether exceedances were indeed modeling artifacts or were potential project related impacts that may actually occur. The sensitivity analysis modeling runs were limited to the Existing Conditions, No Action Alternative, and Alternative 4 Scenario H3, but the findings from these analyses can generally be extended to other scenarios of Alternative 4 and the other project alternatives. These analyses included modeling runs investigating the impact of: changing the Emmaton electrical conductivity compliance location to Threemile Slough, monthly-daily patterning at the Delta boundary locations, including the Montezuma Slough Salinity Control Gates under the alternatives, removing 65,000 acres of Delta restoration (as a means of understanding the contribution to exceedances of restoration vs. CM1), and revising head of Old River Barrier operations during April–May. Additionally, evaluation of individual exceedances at Emmaton was conducted to determine the most likely cause of each exceedance. A complete discussion of the sensitivity analysis modeling runs performed and the results for EC is included in Appendix 8H, *Electrical Conductivity,* Attachment 1.

Mercury and Methylmercury

Mercury is an element of concern for the Delta, its tributaries, Suisun Marsh, and San Francisco Bay because of contamination from historical upstream sources originating from mercury mines in the Coast Ranges (via Putah and Cache creeks to the Yolo Bypass) and gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne river sources) (Alpers et al. 2008; Wiener et al. 2003). Examples of primary mercury sources include mercury ore tailings (e.g., Cache Creek) or elemental mercury from gold field use (e.g., Eastside tributaries). The mercury supplied from historical gold mining processes appears to be the most bioavailable of the two primary sources (Central Valley Regional Water Quality Control Board 2008a). Although atmospheric deposition is a source of mercury, none of the proposed actions affect that source and in the case of the California Central Valley, mining sources completely dominate loading (Central Valley Regional Water Quality Control Board 2011b).

The bioavailability and toxicity of mercury (from whatever primary source) is greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands or wetlands. These stagnant locations with reduced oxygen concentrations promote chemical reduction processes that make methylation possible.

Areas of enhanced bioavailability and toxicity of mercury (created through the mercury methylation process) exist in the Delta, and elevated mercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife. Consequently, the beneficial uses (Table 8-1) most directly affected by mercury include shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and Rare, Threatened, and Endangered species resources that can be exposed to bioaccumulation of mercury. Because of these concerns, mercury was the first TMDL approved for San Francisco Bay in 2007 (San Francisco Bay Water Board 2006), and a methylmercury TMDL was promulgated for the Delta (Central Valley Regional Water Quality Control Board 2011b). The Delta, many direct tributaries to the Delta (i.e., Sacramento River, San Joaquin River, Mokelumne River, Putah Creek, and Calaveras River), and downstream areas (e.g., Suisun Bay and Suisun Marsh) are listed as impaired water bodies on the Clean Water Act Section 303(d) lists for mercury in fish tissue (State Water Resources Control Board 2011).

This section summarizes the potential impacts from project-related changes to concentrations of mercury and methylmercury in water and estimated changes to fish tissue concentrations of mercury. A model was developed linking methylmercury concentrations in water to concentrations in Largemouth Bass muscle tissue. Bass tissue mercury concentrations were estimated for each location and time step based on the co-located waterborne methylmercury concentration estimates from DSM2. Details are provided in Appendix 8I, *Mercury*. Refer also to Chapter 25, *Public Health*, for discussion of the effects of mercury to human health.

Applicable mercury objectives for the affected environment for waterborne concentrations are summarized in Table 8-47. In evaluating the potential effects of waterborne mercury as measured by percentage change in assimilative capacity, only total mercury concentrations are judged against the lowest mercury objective of 25 ng/L; all estimates of methylmercury concentrations in water already exceed recommended objectives of 0.06 ng/L and, therefore, no assimilative capacity exists for that compound and no comparable percentage changes in assimilative capacity were used in the evaluation of differences among alternatives.

Table 8-47. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Mercury and Methylmercury in Water

Analyte	CTR[a]	USEPA Recommended Criteria[b]	Delta Methylmercury TMDL[c]	San Francisco Bay Mercury TMDL[d]
Mercury (ng/L)	50	770	–	25
Methylmercury (ng/L)	–	–	0.06	–

Notes: CTR = California Toxics Rule; ng/L = nanograms per liter; TMDL = total maximum daily load.

[a] Criterion for the protection of human health from total recoverable mercury in freshwater (U.S. Environmental Protection Agency 2012b).

[b] Criterion for the protection of chronic exposure from total mercury to freshwater aquatic life (U.S. Environmental Protection Agency 2012b).

[c] The recommended water column TMDL concentration of methylmercury for the protection of fish bioaccumulation (Central Valley Regional Water Quality Control Board 2008a).

[d] The recommended water column 4-day average TMDL concentration for total mercury (U.S. Environmental Protection Agency 2012b).

Fish tissue concentrations were evaluated in relation to the Delta methylmercury TMDL tissue targets of 0.24 mg mercury/kg wet-weight of largemouth bass fillets (muscle tissue) for fish normalized to a standard 350 mm total length (Central Valley Regional Water Quality Control Board 2011b). The normalization is necessary because of the strong dependence of tissue mercury concentrations on fish size and age; all fish tissue mercury results presented in this document are length-normalized. It is assumed that impact evaluations relative to this established locally derived toxicity limit will provide an appropriate surrogate for effects of bioaccumulated mercury exposure to humans and wildlife from fish consumption and relative impacts on the fish. Most measured and modeled (current and future) fish tissue concentrations of mercury exceed the TMDL tissue target levels. Formulation of the fish tissue mercury model and comparisons between measured and modeled fish tissue results are provided in Appendix 8I, *Mercury*. The Central Valley Water Board TMDL water/tissue translation model as well as a model specifically developed using DSM2 water outputs to predict fish tissue concentrations are compared in Appendix 8I.

Water quality data from the Delta and Suisun Marsh include records of mercury and methylmercury waterborne concentrations as total or filtered water fractions. Water quality summary information since 1999 is shown in Table 8-48 and Table 8-49. The general pattern of mercury waterborne loading to the Delta shows the dominance of mercury mining sources via Cache Creek and Yolo Bypass (Central Valley Regional Water Quality Control Board 2011c); however, the waterborne average concentrations do not reflect the same pattern as loads (Table 8-48). Instead, the Eastside tributary streams and San Joaquin River show higher mercury and methylmercury concentrations than the Sacramento River inputs.

Table 8-48. Historical Mercury Concentrations in the Five Delta Source Waters for the Period 1999–2008

Data Parameters	Source Water: Sacramento River[a]		San Joaquin River[a]		San Francisco Bay[a]		East Side Tributaries[a]		Agriculture within the Delta[b]	
Mean (ng/L)	4.1	–	7.6	0.8	7.8	–	8.6	1.4	6.5	–
Minimum (ng/L)	1.2	–	3.1	0.3		–	0.3	1.4	–	–
Maximum (ng/L)	30.6	–	21.7	3.0		–	26.2	1.4	–	–
75th Percentile (ng/L)	5.5	–	8.6	1.2		–	7.5	1.4	–	–
99th Percentile (ng/L)	24.2	–	17.4	2.8		–	25.2	1.4	–	–
Data Source	CVRWQCB 2008[a]	–	BDAT 2010; CVRWQCB 2008[a]	BDAT 2010; USGS 2010	SFEI 2010	–	CVRWQCB 2008[a]	USGS 2010	CVRWQCB 2008[a]	–
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Martinez		Mokelumne and Calaveras Rivers[b,c]	Cosumnes River[d]	Mid-Delta locations, median	
Date Range	1999–2002	–	2000–2004	2000–2002	2007	–	2000–2001; 2003–2004	2002	2008	
ND Replaced with RL	Not applicable		Not applicable		–		Not applicable		Not applicable	
Data Omitted	None		None		–		None		None	
No. of Data Points	45	–	49	19	–	–	25	1	–	–

Sources: Bay Delta and Tributaries Project (BDAT) 2010; Central Valley Regional Water Control Board (CVRWQCB) 2008a; San Francisco Estuary Institute (SFEI) 2010; U.S. Geological Survey (USGS) 2010.

Notes: Means are geometric means. ND = non-detection; ng/L = nanograms per liter; RL = reporting limit.

[a] The total recoverable concentration of the analyte is presented in first cell and the dissolved concentration of the analyte is presented in the second cell.

[b] Mokelumne River at Interstate 5.

[c] Calaveras River at rail road upstream of West Lane.

[d] Cosumnes River at Michigan Bar.

Table 8-49. Historical Methylmercury Concentrations in the Five Delta Source Waters for the Period 2000–2008

Source Water	Sacramento River[a]		San Joaquin River[a]		San Francisco Bay[a]		East Side Tributaries[a]		Agriculture within the Delta[a]	
Mean (ng/L)	0.10	0.03	0.15	0.03	0.032	–	0.22	0.08	0.25	
Minimum (ng/L)	0.05	0.03	0.09	0.01		–	0.02	0.02	–	–
Maximum (ng/L)	0.24	0.03	0.26	0.08		–	0.32	0.41	–	–
75th Percentile (ng/L)	0.12	0.03	0.18	0.06		–	0.20	0.15	–	–
99th Percentile (ng/L)	0.23	0.03	0.26	0.08		–	0.31	0.39	–	–
Data Source	CVRWQCB 2008a		BDAT 2010; CVRWQCB 2008a	BDAT 2010; CVRWQCB 2008a; USGS 2010	SFEI 2010	–	CVRWQCB 2008a	CVRWQCB 2008a; USGS 2010	CVRWQCB 2008a	–
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Martinez		Mokelumne and Calaveras Rivers	Mokelumne and Cosumnes Rivers	Mid-Delta locations, median	
Date Range	2000–2003	2000	2000–2001; 2003–2004	2000–2002	2007	–	2000–2001; 2003–2004	2000; 2002	2008	–
ND Replaced with RL	Not applicable		Not applicable	Yes	–		Yes	Yes	Not applicable	
Data Omitted	None		None		–		None		None	
No. of Data Points	36	1	49	25	–	–	27	9	–	–

Sources: Bay Delta and Tributaries Project (BDAT) 2010; Central Valley Regional Water Control Board (CVRWQCB) 2008a; San Francisco Estuary Institute (SFEI) 2010; U.S. Geological Survey (USGS) 2010.

Notes: Means are geometric means. ND = non-detection; ng/L = nanograms per liter RL = reporting limit.

[a] The total recoverable concentration of the analyte is presented in first cell and the dissolved concentration of the analyte is presented in the second column.

Nitrate

Applicable nitrate objectives for the affected environment utilized in this assessment are summarized in Table 8-50. The 5 mg/L-N threshold is for irrigation water as recommended by Ayers and Westcot (1994), who recommend a value of 5 mg/L nitrate-N for sensitive crops (e.g., sugar beets, grapes, apricot, citrus, avocado, grains). The concern for these crops is that too much nitrate may cause greater growth than desired, diluting sugars and flavors and thus lowering the value of the crop. However, at levels below 5 mg/L-N, it is assumed that nitrate is beneficial for these crops, and thus increases below the 5 mg/L-N threshold are generally not of concern for agriculture. This 5 mg/L-N Ayers and Westcot (1994) threshold has not been identified as a recommended criterion by U.S. EPA, nor has it been adopted by the state as a water quality objective.

Table 8-50. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Nitrate (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plan[a]	California Toxics Rule	Drinking Water MCL	USEPA Recommended Criteria	Other Relevant Thresholds[b]
Nitrate-N	–	30 100	–	10	10[c]	5

Notes: MCL = maximum contaminant level; mg/L = milligrams per liter; USEPA = U.S. Environmental Protection Agency.

[a] San Francisco Bay Water Board (2007). 30 mg/L nitrate-N criterion for irrigation water; 100 mg/L nitrate-N criterion for livestock watering.

[b] Ayers and Westcot (1994). Recommended goals for sensitive crops.

[c] For the consumption of water and organisms.

Table 8-51 characterizes nitrate concentrations in source waters to the Delta. Data indicate that the San Joaquin River and agriculture within the Delta contain the highest nitrate concentrations, while concentrations in the Sacramento River, San Francisco Bay, and East Side Tributaries are considerably lower. Both the Sacramento and San Joaquin Rivers exhibit seasonal patterns in nitrate concentration.

Nitrate does not behave conservatively in the environment. It can be created via conversion from ammonia to nitrate and can be taken up and metabolized by organisms and sediments. However, because nitrate concentrations vary considerably between the source waters to the Delta, conservative modeling via DSM2 and the mass-balance approach described in Section 8.3.1.3, *Plan Area*, was employed to provide a characterization of changes in nitrate concentration anticipated as a result of changes in source water fractions throughout the Delta alone (using mean concentrations from Table 8-51). Addition and loss mechanisms are considered qualitatively in the context of the quantitative mixing results to characterize changes in nitrate concentrations under the alternatives assessed.

As discussed in Section 8.1.3.10, *Nitrate/Nitrite and Phosphorus*, a host of biological and physical factors affect algal species composition and abundance in the Delta. For algal species in general, and *Microcystis* in particular, the research describing the link between nutrient concentrations/ratios and toxic algal blooms is not conclusive about the type of effect small changes in nutrient levels or nutrient ratios would have on such algal blooms (see also Section 8.1.3.18, *Microcystis*). Our ability to model changes in nutrient ratios attributable to the project is limited by a lack of availability of a suitable model. Changes in nitrate levels that can be estimated using conservative mixing (i.e., no uptake, loss or transformation) models are small enough that predictions of what these changes would mean to the makeup of algal communities or to changes in the N:P ratio would be speculative. Further, since the Delta is thought to be light limited and nutrients are in excess relative to algal growth requirements, these types of changes would not be expected to measurably change the quantity or composition of algae in the Delta. While temperature can affect the rates of creation and loss of nitrate in the affected environment, as discussed above for DO, temperature is not expected to change substantially under the project alternatives, relative to the No Action Alternative. Temperature increases due to climate change, relative to Existing Conditions, are expected to be < 5°F, which is not considered a great enough change to substantially affect nitrate levels.

Table 8-51. Nitrate Concentrations in the Source Waters to the Delta

Source Water	Sacramento River[a]	San Joaquin River[a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta[a, b]
Mean (mg/L as N)	0.068–0.209	0.791–1.839	0.07	0.17	0.059–3.833
Minimum (mg/L as N)	0.023–0.113	0.068–1.175	0.026	0.010	0.002–0.339
Maximum (mg/L as N)	0.136–0.553	2.123–3.614	0.12	1.70	0.135–54.644
75th Percentile (mg/L as N)	0.09–0.248	1.017–2.169	0.09	0.16	0.068–4.516
99th Percentile (mg/L as N)	0.122–0.545	1.992–3.479	0.12	0.99	0.133–34.182
Data Source	DWR	DWR	SFEI	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	BD40 (Just west of Carquinez Straight)	Mokelumne River, Cosumnes River	See footnote[b]
Date Range	1997–2008	1990–2009	1993–2001	1961–1993	1990–2001
ND Replaced with RL	No	No	No	No	Yes
Data Omitted	Data prior to 1992 (EPA Method 353.2; poor detection limit)	Two values > 9 mg/L as N	None	Values reported as "0"	None
No. of Data Points	25–33	29–35	25	45	5–81

Notes: DWR = California Department of Water Resources; mg/L = milligrams per liter; ND = non-detection; RL = reporting limit; SFEI = San Francisco Estuary Institute; USGS = U.S. Geological Survey.

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average nitrate at these locations suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at these locations, average monthly concentration was used. Tables of these parameters by month are show in Appendix 8J, *Nitrate*.

[b] Values calculated from all agriculture drain data pooled together. All nitrate data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average nitrate did not vary greatly between regions. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

Organic Carbon

While existing goals and action threshold for organic carbon as a DBP precursor are expressed as TOC, it is the dissolved fraction, expressed as DOC, which is the focus of the organic carbon assessment. As previously stated, 85–90% of Delta TOC is in the DOC or "dissolved" form. Further, while the relative potency of organic carbon as a DBP precursor can vary considerably across samples (CALFED Bay-Delta Program 2008a:5), in the Delta it is generally believed that the dissolved fraction (i.e., DOC) most frequently influences DBP formation potential (CALFED Bay-Delta Program 2007b:5–22). Even within the DOC fraction, DBP formation can vary considerably, indicating that the nature of the organic matter that comprises DOC in a sample is important. Nevertheless, DOC is considered a more accurate surrogate for DBP formation relative to TOC or POC.

Given the strong link between THM and HAA formation potential and organic carbon, THM and HAA formation potential will not be assessed separately, but rather the assessment of organic carbon addresses concerns regarding THM and HAA formation potential.

Table 8-52 provides a summary of DOC concentrations for the Sacramento and San Joaquin Rivers as utilized for DSM2 boundary conditions. As discussed in Section 8.3.1.1, *Models Used and their Linkages*, DSM2 was utilized directly to model and predict DOC at 11 locations across the Delta, and the degree DOC changed under the various project alternatives. Because DOC is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average DOC concentrations at select locations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No.1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Buckley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, effects within the SWP/CVP Export Service Areas are assessed based on DOC concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants). DOC in the Delta is generally considered to act conservatively; thus, the mass-balance modeling approach employed. Moreover, the POC fraction would be largely removed through conventional drinking water treatment (State Water Project Contractors Authority 2007:3–19).

Table 8-52. Monthly Average Dissolved Organic Carbon Utilized in DSM2 Modeling for Sacramento and San Joaquin River Source Waters (mg/L)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento at Hood	1.8	2.3	2.9	3.0	2.9	2.7	2.4	2.0	1.8	1.8	1.8	1.8
San Joaquin at Vernalis	3.4	3.5	3.6	4.7	4.8	4.7	3.9	3.4	3.4	3.4	3.4	3.4

In establishing its source water goal for organic carbon, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with TOC between 4 and 7 mg/L is believed sufficient to meet currently established drinking water criteria for DPBs, depending on the amount of *Giardia* inactivation required (California Urban Water Agencies 1998, ES2). In light of these source water goals and EPA's TOC removal action thresholds, the assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future DOC concentrations would exceed 2, 3, and 4 mg/L on a long-term average basis at the assessment locations. Because, in many cases, the existing condition is one already exceeding 2 and 3 mg/L, the frequency with which DOC exceeds 4 mg/L becomes a key focus of the assessment, as well as the change in long-term average DOC concentration.

An important Delta assessment location is DWR's North Bay Aqueduct intake at Barker Slough. While source-water fingerprinting identifies the Sacramento River as comprising the majority of flow at the Barker Slough location, the quality of water is substantially influenced by local sources in the Barker Slough catchment. These local sources contribute a significant organic carbon load to the

Barker Slough location, where average TOC between 2001 and 2005 was 5.8 mg/L and as high as 20 mg/L in winter months (State Water Project Contractors Authority 2007: 3-19, 3-26). The DSM2 model does not account for these local sources and, therefore, concentrations presented in this assessment generally underestimate baseline DOC conditions. Nevertheless, operations and maintenance activities will not substantially affect these local sources to Barker Slough and thus their contribution to annual average DOC would continue to occur regardless of project alternative implementation. The modeling presented in this assessment for the Barker Slough location accounts for expected changes in DOC relative to changes in Delta hydrodynamics, excluding local watershed sources to Barker Slough.

Pathogens

The assessments of pathogens were conducted in a qualitative manner with consideration to sources of pathogens and factors that contribute to elevated levels in surface waters, including flow rate and distance from pathogen sources.

Pesticides

Assessing pesticide-related effects is substantially challenged by: 1) limited available monitoring data in the Delta and other water bodies of the affected environment, and 2) a continually changing pesticide use market. Due to a number of factors, including historic pesticide use patterns and analytical capabilities, there is more data available for certain classes of pesticides, such as OP insecticides, than that for other classes of pesticides, including herbicides, fungicides, and insecticides such as pyrethroids and carbamates.

Likely the single most recent and comprehensive compilation of pesticide data for the Delta and upstream water bodies (within 30 miles of the Delta) was compiled by Johnson et al. (2010). The result of this compilation and review was the conclusion that there were few chemicals for which data were of sufficient number and quality to allow a definitive conclusion regarding contaminants and toxicological issues in the Delta such as the POD. The stated exception was that of the OP insecticides chlorpyrifos and diazinon, where frequent toxicity to bioassay indicator organisms has been associated with measurable concentrations of chlorpyrifos and diazinon (Kuivila and Foe 1995; Werner et al. 2000). In fact, in the comprehensive review of Johnson et al. (2010), only the analysis of diazinon, chlorpyrifos, several pyrethroid insecticides and the herbicide diuron were carried forward, primarily due to data quantity and quality limitation. In this compilation, cumulative frequency distributions were prepared, suggesting that less than 10% of all samples for chlorpyrifos, diazinon, and diuron would be expected to exceed benchmark toxicity thresholds. Data for the pyrethroid insecticides were too limited, primarily due to data quality issues (i.e., insufficiently low detection limits). However, pyrethroid-related research and regulatory interest has intensified with the fairly recent observation of substantial pyrethroid-associated toxicity in sediments and the water column of numerous urban streams, agricultural drainage canals, and municipal wastewater effluent (Weston and Lydy 2010). These pyrethroid observations are largely believed to be related to their recent increased use as a suitable substitute for diazinon and chlorpyrifos.

Perhaps more challenging than a limited monitoring effort is the dynamic state of the pesticide market. Regulatory and pest resistance pressures have left the pesticide market, namely the insecticide market, in a state of flux. Pesticide use varies from year to year depending on numerous external factors such as climate and associated pest outbreaks, cropping patterns, and economic trends in housing construction and urban development. Layered upon this year-to-year variation is an overall trend of decreased OP insecticides use and increased pyrethroid use, primarily due to the early regulatory phase-out of many OP insecticide uses initiated in early 2000. The market has yet to balance and reach equilibrium, and what limited and relatively short-term monitoring data that is available ultimately only represents a snapshot of a trend in the gradual replacement of many OP uses with that of pyrethroids. Until markets stabilize, trends will inevitably continue to develop.

For rivers, a number of factors are necessary for pesticide-related impacts on beneficial uses to be a possibility. Although a number of relevant beneficial uses exist, for the majority of pesticides aquatic life beneficial uses are the greatest concern. For concentrations of pesticides in surface water to reach thresholds of aquatic life concern, a number of controlling factors are typically at play. First and foremost, pesticides must be used, and used in a location with hydrologic connectivity to surface water, and used in amounts that are not easily diluted in the environment. Secondly, the pesticide must be transportable. The ultimate transportability of a pesticide is largely determined by its individual chemistry, where its chemistry determines important properties such as water solubility, vaporization, and soil sorption. Factors unrelated to the pesticide are also important, such as substrate erosivity, precipitation or irrigation amounts, and time elapsed from application to runoff. Thirdly, the pesticide must be stable in the environment, such that residues of the applied pesticide are present during runoff events. And finally, if transported to surface waters, sufficient amounts of pesticide must be present that once diluted by surface water flows, the resulting concentration is of a magnitude capable of eliciting a measurable effect in aquatic life. All of these factors contribute in the end to the potential for adverse beneficial use effects, but of the many factors involved, CVP/SWP operations only affect river flows and, thus available dilution. In an estuary environment, where substantial dilution capacity typically occurs, duration of aquatic life exposure in addition to pesticide concentration is important. While the capacity of the Delta to dilute pesticide inputs is largely unaffected by CVP/SWP operations, the duration of exposure, or residence time, can be affected by operations. Therefore, in the Delta, changes in source water fractions represent long-term changes in exposure potential.

Similar to the assessment of Johnson et al. (2010), there is insufficient data to perform an assessment of project alternatives' effects on all pesticides. Within available data, however, there is sufficient evidence that the OP insecticides diazinon and chlorpyrifos, and the herbicide diuron may be found in the affected environment at concentrations frequently toxic to aquatic life, and to such a degree that changes in CVP/SWP operations could possibly have an effect. Furthermore, although pyrethroid insecticides have not been demonstrated to have the same magnitude of concern throughout the affected environment, trends in OP replacement, increased pyrethroid use, and increased pyrethroid incidence in urban streams and agricultural drains suggest that pyrethroids may become a broader concern in the future. Therefore, the pesticide assessment focuses on potential effects of CVP/SWP operations into the future, under the various considered alternatives, on diazinon, chlorpyrifos, pyrethroids, and diuron, and the possibility that the frequency or magnitude of existing pesticide-related risk to beneficial uses might change.

The pesticide assessment utilizes recent research and monitoring related to OP, diuron and pyrethroid incidence in ambient waters to qualitatively assess the effects of the alternatives on those pesticides and their possible related aquatic harm. Effects of alternatives on pesticides are primarily incidental and indirect, as existing and future sources of pesticide loading are largely unrelated. Further, effects on pesticides would be related to the change in river flow rates and Delta source water volumes. Because these changes would not directly affect pesticide source loading, but could affect in-stream pesticide concentrations through dilution as well as in-water pesticide dispersion and geographic distribution, changes in CVP/SWP operations could alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. This change in risk can be qualitatively assessed through change in river flows and associated dilution, as well as change in source water fraction and associated opportunity for exposure. Pesticide effect assessments based on dilution flows and source water fraction is heavily burdened by assumptions regarding pesticide use into the future. As well, pesticide effects assessments based on changes in potential risk are heavily burdened by presumptions of real hazard relative to actual in-stream concentrations and actual effect thresholds which cannot be determined. It is assumed that sources of pesticides to water bodies would be similar for all alternatives.

In addition to the present-use pesticides described above, “legacy” pesticides, which have been banned for decades and include numerous organochlorine insecticides including DDT, can still be found in terrestrial soils and riverine sediments throughout the Central Valley. These were assessed based on the understanding that residues of these pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Regional Water Quality Control Board 2010c). These low level sources are widespread and dispersed throughout the Central Valley.

Phosphorus

An analysis of nutrient loads to the Delta found that phosphorus concentrations showed little inter-seasonal variability between the Sacramento and San Joaquin Rivers (Tetra Tech 2006a). Data gathered for this assessment confirm this finding, and also show that little variability exists between these two rivers and between San Francisco Bay water at Martinez. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006a). Table 8-53 summarizes dissolved ortho-phosphate data for source waters to the Delta, and Figure 8-56 shows the seasonal variation in dissolved ortho-phosphate concentrations among the three major source waters. During April through December, ortho-phosphate concentrations from the three major source waters are very similar. During January through March, concentrations in the San Joaquin River at Vernalis are noticeably greater than from the Sacramento River at Hood/Greene’s Landing or San Francisco Bay at Martinez. Phosphorus levels in the Sacramento River are not expected to increase due to treatment upgrades at SRWTP (which is an action completely separate from the project alternatives). This is because SRWTP will implement treatment upgrades that will keep phosphorus levels in the plant’s discharge at or below current levels. Therefore, phosphorus levels in the Sacramento River inflows to the Delta under the No Action Alternative (early long-term [ELT] and late long-term [LLT]) and action alternatives would not be affected by this action relative to Existing Conditions.

Table 8-53. Summary of Dissolved Ortho-Phosphate Concentrations (mg/L-P) in Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries
Mean (mg/L as P)	0.068	0.106	0.092	0.018
Minimum (mg/L as P)	0.010	0.010	0.030	0.010
Maximum (mg/L as P)	0.24	0.45	0.18	0.090
75th Percentile (mg/L as P)	0.090	0.130	0.11	0.020
99th Percentile (mg/L as P)	0.18	0.28	0.17	0.06
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS
Station(s)	Sac River at Greene's Landing (BDAT only), Sac River at Hood	San Joaquin River at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River
Date Range	1975–2009	1975–2009	1975–2006	1977–1994
ND Replaced with RL	No	No	No	Yes
Data Omitted	None	None	None	Single value reported as "0"
No. of Data Points	523	502	203	100

Notes: BDAT = Bay Delta and Tributaries Project; DWR = California Department of Water Resources; mg/L = milligrams per liter; ND = non-detection; RL = reporting limit; USGS = U.S. Geological Survey.

Phosphorus does not behave conservatively in the environment, e.g., it can be taken up and metabolized by organisms or lost to or supplied by sediment. While at times phosphorus in the Delta and its source waters can be bound primarily in suspended sediment, there is limited ability to predict changes in total phosphorus concentrations because there are no sediment transport models for the Delta. Because phosphorus concentrations do not vary considerably between the major source waters (as discussed above), phosphorus was assessed qualitatively. The primary way in which the project alternatives could affect phosphorus levels is by increasing the fraction of San Joaquin River water at point in the Plan Area during January through March. Thus, source water fractions for the San Joaquin River were analyzed for that period to determine if the changes would be expected to substantially affect phosphorus concentrations. As unpredictable as they may be, levels of total phosphorus could be directly influenced by changes in suspended sediment-bound phosphorus. Therefore, changes in phosphorus levels were qualitatively assessed on the basis of changes in TSS and turbidity levels.

As discussed in Section 8.1.3.10, *Nitrate/Nitrite and Phosphorus,* a host of biological and physical factors affect algal species composition and abundance in the Delta. For algal species in general, and *Microcystis* in particular, the research describing the link between nutrient concentrations/ratios and toxic algal blooms is not conclusive about the type of effect small changes in nutrient levels or nutrient ratios would have on such algal blooms (see also Section 8.1.3.18, *Microcystis*). Our ability to model changes in nutrient ratios attributable to the project is limited by a lack of availability of a suitable model. Changes in phosphorus levels that can be estimated using conservative mixing models are small enough that predictions of what these changes would mean to the makeup of algal communities or to changes in the N:P ratio would be speculative. Further, since the Delta is thought to be light limited and nutrients are in excess relative to algal growth requirements, these types of changes would not be expected to measurably change the quantity or composition of algae in the Delta.

Selenium

Potential impacts may occur from project-related changes to concentrations of selenium in water as well as changes to concentrations in fish tissues (whole-body and fillets) and bird eggs. Bioaccumulation models were developed linking selenium concentrations in water to concentrations in fish tissue and bird eggs, which were estimated for each assessment location and alternative based on the modeled selenium concentration estimates for water from DSM2 (as described in Appendix 8M, *Selenium*), and from water to whole-body sturgeon in the western Delta (as described in Appendix 8M). Because of differences in bioaccumulation among water-year types, one model was used for all water years and a modified model was developed for drought years (when bioaccumulation was higher for fish). Detailed results are presented in Appendix 8M.

Applicable selenium objectives for water in the affected environment are summarized in Table 8-54, and selected benchmarks for assessment of selenium in whole-body fish, bird eggs, and fish fillets are presented in Table 8-55.

Table 8-54. Applicable Federal Criteria, State Standards/Objectives, and Other Relevant Effects Thresholds for Selenium

	Region 5 Basin Plan[a]	Region 2 Basin Plan[b]	California Toxics Rule[c]	Drinking Water MCL[d]	USEPA Recommended Criteria[e]	Other Relevant Thresholds[f]
Selenium micrograms per liter (µg/L)	5/12	5/20	5/20	50	5/variable 1.3	2

[a] Objectives apply to the lower San Joaquin River from the mouth of the Merced River to Vernalis as 5 µg/L (4-day average) and 12 µg/L (maximum concentration) total selenium concentration (Central Valley Regional Water Quality Control Board 2009a).

[b] Selenium criteria were promulgated as total recoverable concentrations for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR) (U.S. Environmental Protection Agency 1992; San Francisco Bay Water Board 2007).

[c] Standard is Criterion Continuous Concentration as 5 µg/L total recoverable selenium; California Toxics Rule deferred to the NTR for San Francisco Bay/Delta waters and San Joaquin River (U.S. Environmental Protection Agency 2000).

[d] Maximum Contaminant Level. In addition, the California Office of Environmental Health Hazard Assessment (California Office of Environmental Health Hazard Assessment 2010) has recommended a Public Health Goal of 30 µg/L.

[e] Adopted Criteria for protection of freshwater aquatic life are 5 µg/L (continuous concentration, 4-day average) total recoverable selenium and they vary for the Criterion Maximum Concentration (CMC; 24-hour average) (U.S. Environmental Protection Agency 2012b). The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively. Draft Criterion for water concentrations in lentic systems 1.3 µg/L (U.S. Environmental Protection Agency 2014).

[f] Concentration as total recoverable selenium identified as a Level of Concern for the Grassland Bypass Project (Beckon et al. 2008).

Table 8-55. Selected Benchmarks for Assessment of Selenium in Whole-body Fish, Bird Eggs, and Fish Fillets

	Whole-Body Fish[a]		Bird Eggs[a]		
	Low[c]	High[d]	Low[e]	High[f]	Fish Fillets[b]
Selenium	4	8.1	6	10	2.5

[a] Milligrams per kilogram (mg/kg), dry-weight basis.
[b] mg/kg, wet-weight basis; Advisory Tissue Level (California Office of Environmental Health Hazard Assessment 2008).
[c] Level of Concern for whole-body fish (lower end of range) (Beckon et al. 2008). For sturgeon the low benchmark was 5 mg/kg, dry weight (Presser and Luoma 2013).
[d] Toxicity Level for whole-body fish (U.S. Environmental Protection Agency 2014). For sturgeon the high benchmark was 8 mg/kg, dry weight (Presser and Luoma 2013).
[e] Level of Concern for bird eggs (lower end of range) (Beckon et al. 2008).
[f] Toxicity Level for bird eggs (Beckon et al. 2008).

The State Water Board lists the western Delta as having impaired water quality for selenium and several other constituents under Clean Water Act Section 303(d) (State Water Resources Control Board 2011). The Central Valley Water Board completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001, and USEPA approved this in 2002 (Central Valley Regional Water Quality Control Board 2001, 2009d). Historical selenium concentrations in source waters to the Delta are shown in Table 8-56. DSM2 modeling for other constituents considered five sources of water to the Delta, as described in Section 8.3.1.3, *Plan Area*. However, for selenium, the Sacramento River mean concentration upstream of the American River (as measured below Knights Landing, upstream of the Yolo Bypass) was somewhat higher than that at Freeport (representing the main flow of the river to the Delta). Consequently, the value for Knights Landing was used as the input through the Yolo Bypass and the value for Freeport was used to represent the main flow of the Sacramento River to the Delta.

Table 8-56. Historical Selenium Concentrations in the Six Delta Source Waters for the Period 1996–2014

Source Water	Sacramento River[a]	San Joaquin River[b]	San Francisco Bay[a]	East Side Tributaries[c]	Agriculture within the Delta[a]	Yolo Bypass[d]
Mean (µg/L)[e]	0.09	0.45	0.10	0.10	0.11	0.23
Minimum (µg/L)	0.04	0.07	0.06	0.10	0.11	0.19
Maximum (µg/L)	0.23	1.50	0.45	0.10	0.11	0.30
75th percentile (µg/L)	0.11	0.76	0.12	0.10	0.11	0.29
99th percentile (µg/L)	0.23	1.50	0.44	0.10	0.11	0.30
Data Source	USGS 2014	USGS 2014	SFEI 2014	None	Lucas and Stewart 2007	DWR 2009b
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis	Central-West; San Joaquin River near Mallard Island (BG30)	None	Mildred Island, Center	Sacramento River below Knights Landing
Date Range	11/2007–7/2014	11/2007–8/2014	2/2000–8/2013	None	2000	2004, 2007, 2008
ND Replaced with RL	Not applicable	Not applicable	No	Not applicable	No	Yes
Data Omitted	None	None	None	Not applicable	None	None
No. of Data Points	88	93	14	None	1	5

Notes: ND = non-detection; RL = reporting limit; SFEI = San Francisco Estuary Institute; SWAMP = Surface Water Ambient Monitoring Program; µg/L = micrograms per liter.

[a] Dissolved selenium concentration.

[b] Not specified whether total or dissolved selenium.

[c] Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes Rivers is assumed to be 0.1 µg/L due to lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 µg/L.

[d] Total selenium concentration.

[e] Means are geometric means.

Largemouth bass collected from sites near the source locations or within the Delta in 2000, 2005, and 2007 were analyzed for selenium (Foe 2010). Measured selenium concentrations in those fish and modeled selenium concentrations in whole-body fish at three source water locations are presented in Table 8-57. Selenium concentrations in fish fillets, whole-body fish, and bird eggs at assessment locations in the Delta were estimated using models described in Appendix 8M, *Selenium*.

Table 8-57. Measured and Modeled Selenium Concentrations (milligrams per kilogram, dry-weight basis) in Whole-Body Fish at or near Source Water Locations to the Delta

	Sacramento River[a]		San Joaquin River[b]		Suisun Bay[c]	
Year	Measured	Modeled	Measured	Modeled	Measured	Modeled
2000	2.6	1.5[d]	1.7	1.9[e]	No Data	1.5[f]
2005	1.5	1.5[d]	1.9	1.9[e]	No Data	1.6[f]
2007	1.8	2.5[g]	2.4	2.4[h]	No Data	2.5[i]

Notes: K_d = particulate/water ratio; TTF_{fish} = trophic transfer factor from diet to fish; $TTF_{invertebrate}$ = trophic transfer factor from particulate to invertebrate.

[a] Sacramento River Mile 44.

[b] Vernalis.

[c] Montezuma Slough near Grizzly Bay; bass were not sampled near here, so modeled values are for the nearest location where bass were sampled (Big Break), for which the waterborne selenium concentration (0.10 µg/L) was the same as that for the San Joaquin River at Mallard Island.

[d] Concentration of selenium estimated from Model 4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 4909 to 4997 (varying by year and quarter in 2000 [4910 to 4997] and 2005 [4909 to 4910]), $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[e] Concentration of selenium estimated from Model 4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 665 in 2000 and 651 in 2005, $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[f] Concentration of selenium estimated from Model 4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1683 to 4804 (varying by year and quarter in 2000 [2441 to 4593] and 2005 [1683 to 4804]), $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[g] Concentration of selenium estimated from Model 5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 8061 to 8064 (varying by quarter), $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[h] Concentration of selenium estimated from Model 5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1206, $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[i] Concentration of selenium estimated from Model 5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 6220 to 7926 (varying by quarter), $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

Trace Metals

Water quality criteria used in the assessment of trace metals are presented in Table 8-58. The CTR criteria for cadmium, chromium (III), copper, lead, nickel, silver, and zinc are promulgated as equations that contain three adjustments: 1) the water-effect ratio (WER), 2) the conversion factor (CF) from total to dissolved fraction, and 3) hardness (freshwater criteria only), which are used to adjust the criteria based on site-specific water quality conditions in order to provide the level of protection intended by U.S. EPA. Table 8-59 presents hardness adjusted CTR criteria for the primary Delta source waters, including the Sacramento and San Joaquin Rivers. Criteria were calculated based on each source waters average and 5th percentile hardness (See Appendix 8N, *Trace Metals*, for hardness data). Due to lower average and 5th percentile hardness on the Sacramento River, calculated hardness-based metals aquatic life criteria are lowest on the Sacramento River.

The quality of water representative of the Bay source water fraction is highly seasonal, with conditions ranging between freshwater and saltwater conditions. In such a case, CTR metals criteria guidance states that the more stringent of the freshwater or saltwater criteria is to be used. Comparing saltwater criteria listed in Table 8-58 to freshwater criteria in Table 8-59, saltwater criteria for copper and nickel are more stringent than the corresponding hardness-based freshwater criteria.

Table 8-58. Water Quality Criteria and Objectives for Trace Metals (µg/L)

	Freshwater		Saltwater		Human Health			
Metal	Acute[a]	Chronic[a]	Acute[a]	Chronic[a]	Water & Organisms	Organisms Only	Region 5 Basin Plan	California Drinking Water MCLs[e]
Aluminum	87[f]	750[f]	NA	NA	NA	NA	NA	200
Arsenic	340	150	69	36	NA	NA	10[b]	10
Cadmium	4.3/3.9[c]	2.2/1.1[c]	42	9.3	NA	NA	0.22[d]	5
Chromium (III)	550	180	NA	NA	NA	NA	NA	50
Copper	13	9	4.8	3.1	1,300	NA	5.6[d]/10[b]	1,000
Iron	NA	1,000[f]	NA	NA	NA	NA	300[b]	300
Lead	65	2.5	210	8.1	NA	NA	NA	15
Manganese	NA	NA	NA	NA	NA	NA	50[b]	50
Nickel	470	52	74	8.2	610	4,600	NA	100
Silver	3.4	NA	1.9	NA	NA	NA	10[b]	100
Zinc	120	120	90	81	NA	NA	100[b]/16[d]	5,000

Notes: All values in micrograms per liter (µg/L) and expressed as dissolved metal, unless otherwise noted.
NA = non-applicable.

[a] Values represent both California Toxic Rule (CTR)/National Toxics Rule criteria and criteria contained within the Region 2 Basin Plan. Acute values are applicable to short periods of time, generally defined as 1-houraverage concentrations. Chronic values are defined as 4-day average concentrations. For metals whose CTR criteria allow for adjustments based on water-effect ratio (WER), conversion factor (CF), and hardness, values in the table assume a default WER of 1.0, default CFs contained within the CTR, and a default hardness of 100 milligrams per liter (as $CaCO_3$).

[b] Applies at the following locations: Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake; and the Sacramento-San Joaquin Delta.

[c] First value is the CTR cadmium criterion, second value is Region 2 Basin Plan criterion.

[d] Applies to the Sacramento River and its tributaries above State Route 32 bridge at Hamilton City.

[e] Expressed as total recoverable metal.

[f] U.S. Environmental Protection Agency 304(a) national recommended criteria.

Metals differ in their physical and chemical parameters and thus in their fate, transport, and bioavailability in the aquatic environments. Throughout the trace metals assessment dissolved metals concentrations are utilized, because the dissolved fraction better approximates the bioavailable fraction to aquatic organisms. Furthermore, drinking water treatment plants readily remove particulate and suspended matter from raw water. While maximum contaminant levels for treated drinking water are measured on a total recoverable basis, the dissolved fraction of these metals is taken as the more accurate predictor of metals concentration post-treatment. This is particularly the case with aluminum, iron, and manganese which are naturally abundant in soil. Total recoverable aluminum, iron, and manganese concentrations can be very high in water carrying a substantial load of suspended matter (i.e., TSS). Therefore, assessment of aquatic life and drinking water effects utilizes the dissolved fraction of trace metals in the environment.

Table 8-59. Hardness-Based Dissolved Freshwater Aquatic Life Criteria by Primary Source Water (µg/L)

	Criteria for Sacramento Source Water Based on 5th Percentile Hardness		Criteria for Sacramento Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	0.81	0.128	1.19	0.168
Copper	5.53	4.006	8.04	5.623
Chromium (III)	263.50	34.276	364.71	47.441
Lead	22.86	0.891	35.52	1.384
Nickel	211.11	23.448	295.34	32.803
Silver	0.64	–	1.26	–
Zinc	52.77	53.199	73.86	74.464
	Criteria for San Joaquin Source Water Based on 5th Percentile Hardness		Criteria for San Joaquin Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	1.13	0.162	2.93	0.321
Copper	7.65	5.373	19.32	12.447
Chromium (III)	349.18	45.421	781.14	101.610
Lead	33.49	1.305	97.98	3.818
Nickel	282.37	31.362	648.66	72.046
Silver	1.15	–	6.24	–
Zinc	70.61	71.187	162.41	163.742
	Criteria for Bay Source Water Based on 5th Percentile Hardness		Criteria for Bay Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	1.11	0.160	13.98	0.981
Copper	7.52	5.290	88.25	49.357
Chromium (III)	343.97	44.744	2925.17	380.504
Lead	32.82	1.279	518.97	20.224
Nickel	278.02	30.879	2537.13	281.796
Silver	1.11	–	99.88	–
Zinc	69.52	70.089	636.59	641.798

Notes: Criteria calculated based on each source waters average and 5th percentile hardness.
µg/L = micrograms per liter.

Research has shown that elevated copper levels in water bodies are of concern for disruption of olfactory cues in salmonids when migrating to their natal streams to spawn, which can lead to increased straying. However, the U.S. EPA-developed biotic ligand model (BLM)-based copper criteria have been shown to always be protective of these concerns (Meyer and Adams 2010: 2096). Because of this, BLM-based copper criteria were derived for the Sacramento and San Joaquin Rivers, as shown in Table 8-60. The BLM criteria account for the aggregate effect of several different water quality parameters on copper toxicity in addition to hardness (e.g., dissolved organic carbon, pH, and various salt concentrations), with the protective criterion being sensitive to DOC concentrations in water. When calculated based on the average of all necessary parameters and the 5th percentile DOC, copper BLM-based criteria were higher (i.e., less sensitive) than the corresponding non WER-adjusted copper criteria presented in Table 8-59. Therefore, the calculated hardness-based CTR copper criteria are found to be adequately protective of fish olfaction.

Table 8-60. Biotic Ligand Model-Based Criteria for Dissolved Copper (µg/L)

	CMC	CCC
Sacramento		
Average of all BLM parameters	10.9299	6.7888
5th Percentile DOC; Average of remaining parameter	6.9774	4.3338
San Joaquin		
Average of all BLM parameters	15.9659	9.9167
5th Percentile DOC; Average of remaining parameter	10.0879	6.2658
Notes: BLM = biotic ligand model; DOC = dissolved organic carbon; µg/L = = micrograms per liter.		

There is currently no single program or effort for the coordinated and comprehensive measurement of trace metals in the Delta and its primary source waters. Moreover, analytical techniques for trace metals measurement have improved considerably over time, often resulting in substantially lower detection limits and at time showing earlier techniques to be prone to analytical error. Nevertheless, local monitoring efforts such as the San Francisco Bay RMP and the Sacramento Coordinated Regional Monitoring Program have collected trace metals on the Sacramento River and the San Francisco Bay for more than a decade, resulting in an adequate long-term characterization of these waters. Unfortunately, there has been no equivalent effort on the San Joaquin River, eastside tributaries, or within the Delta itself. This imbalance in available data limits the effects assessment approach. Effects are qualitatively assessed.

Summaries of trace metals data compiled for this qualitative assessment are provided in Appendix 8N, *Trace Metals*. Data of sufficient quality were available for the Bay, Sacramento River and San Joaquin River source waters, although data for the San Joaquin are very few. These data used to inform the qualitative assessment on trace metal effects upstream of the Delta, within the Delta, and the SWP and CVP service areas. Due to the relatively short exposure durations related to aquatic life acute and chronic effects, long-term trace metals effects are evaluated on a 95th percentile concentration basis. Due to the relatively long exposure durations related to drinking water effects, long-term trace metals effects are evaluated on an average concentration basis.

Total Suspended Solids and Turbidity

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

TSS and turbidity in Delta waters is affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS and turbidity within Delta waters also is affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are the near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

The TSS and turbidity assessments were conducted in a qualitative manner based on anticipated changes in these factors.

Microcystis

Microcystis has an annual life cycle characterized by two phases. The first is a benthic phase, during which cysts overwinter in the sediment. In the second planktonic phase, during summer and fall, *Microcystis* enters the water column and begins to grow. When environmental conditions, such as sufficiently warm water temperatures, trigger *Microcystis* recruitment from the sediment, the organism is resuspended into the water column through a combination of active and passive processes (Verspagen et al. 2004; Mission and Latour 2012). In the Delta, there are five primary environmental factors that trigger the emergence and subsequent growth of *Microcystis*.

1. Warm water temperatures (>19°C) (Lehman et al. 2013).
2. Nutrient availability (e.g., nitrogen and phosphorus) (Smith 1986; Paerl 2008 as cited in Davis et al. 2009).
3. Water column irradiance and clarity (surface irradiance >100 Watts per square meter per second and total suspended solid concentration <50mg/L (Lehman et al. 2013).
4. Flows and long residence times (Lehman et al. 2013).

Microcystis blooms typically develop over a period of several weeks after cells emerge from the benthic state (Marmen et al. 2016). Because environmental conditions and benthic recruitment drive *Microcystis* formation within the water column, it is common for many *Microcystis* cells to enter the water column at the same time. Once in the water column, and when environmental conditions are favorable, *Microcystis* rapidly multiplies. One study found the doubling time of *Microcystis aeruginosa* strains ranged from 1.5 to 5.2 days, with an average doubling time of 2.8 days (Wilson et al. 2006). This fast growth rate allows cells to form colonies which come together to form a “scum” layer at the water surface. In the Delta, scums are primarily composed of the colonial form of *Microcystis*, but single cells are also present (Baxa et al. 2010).

Like many cyanobacteria species, *Microcystis* possess specialized intracellular gas vesicles that enable the organism to regulate its buoyancy (Reynolds 1981 as cited in Paerl et al. 2014). This buoyancy allows *Microcystis* to take advantage of near surface areas with optimal growth conditions (e.g., light). The collection of cells at the surface, primarily in calm waters, allows *Microcystis* to sustain a competitive advantage over other phytoplankton species by optimizing their photosynthetic needs while shading out other algal species, which they compete with for nutrients and light (Huisman et al. 2004).

Wind and tides can enhance the aggregation of *Microcystis* cells in slow moving waters (Baxa et al. 2010), but in faster moving, turbulent waters, the ability of *Microcystis* to maintain its positive buoyancy is reduced (Visser et al. 1996). Therefore, high flow rates make it difficult for *Microcystis* to collect and form dense colonies at the water surface. Turbulence effects metabolic processes and cell division (Koch 1993; Thomas et al. 1995 as cited in Li et al. 2013) and thus can be a negative growth factor (Paerl et al. 2001 and articles cited within). Turbulent water mixes all algae throughout the photic zone of the water column and reduces light through turbidity which allows faster growing chlorophytes (green algae) and diatoms to outcompete the slower growing cyanobacteria, including *Microcystis* (Wetzel et al. 2001; Huisman et al. 2004; Li et al. 2013). Although the amount of flow required to disrupt a *Microcystis* bloom varies by system, in the Zhongxin Lake system China, flow velocities of 0.5–1.0 feet/second shifted the dominant phytoplankton species from cyanobacteria to green algae and diatoms (Li et al. 2013).

As described under Impact WQ-29 (Effects on TSS and Turbidity), changes in TSS and turbidity levels within the Delta under the project alternatives could not be quantified, but are expected to be similar under the project alternatives to Existing Conditions and the No Action Alternative. Minimal changes in water clarity would result in minimal changes in light availability for *Microcystis* under the project alternatives. As such, the project alternatives' influence on *Microcystis* production in the Delta, as influenced by the project alternatives' effects on Delta water clarity, is considered to be negligible.

Regarding nutrients the maintenance of *Microcystis* blooms in the Delta requires the availability of the nitrogen and phosphorus. However, the body of science produced by scientists studying *Microcystis* blooms in the Delta and elsewhere does not indicate that the specific levels of these nutrients, or their ratio, currently control the seasonal or inter-annual variation in the bloom. A large fraction of ammonia in the Sacramento River will be removed due to planned upgrades to the Sacramento Regional County Sanitation District's SRWTP, which will result in >95% removal of ammonia from the effluent discharge from this facility. Following the SRWTP upgrades, levels of ammonia in Sacramento River are expected to be similar to background ammonia concentrations in the San Joaquin River and San Francisco Bay (see Section 8.3.3.1, Impact WQ-1). The response of *Microcystis* production in the Delta to the substantial reduction in river ammonia levels (from removing ammonia from the SRWTP discharge) is unknown because nitrate and phosphorus levels in the Delta will remain well above thresholds that would limit *Microcystis* blooms.

Nutrient ratios in excess of the Redfield N:P ratio of 16 have also been hypothesized to favor *Microcystis* growth in the Delta (Glibert et al. 2011). However, considerable doubt has been cast on this hypothesis because median N:P molar ratios in the Delta during peak bloom periods are usually near or a little lower than the Redfield ratio of 16 needed for optimum phytoplankton growth, and when ammonia is considered the sole N source, the N:P ratio drops substantially to a median of 1.31:1 (Lehman et al. 2013). Based on this information, there is no evidence as to what type of effect small changes in nutrient concentrations and ratios would have on *Microcystis* blooms, given that such blooms are largely influenced by a host of other physical factors, including water temperature and water residence time within channels.

Based on the above, water clarity and nutrient effects on *Microcystis* were determined to not have substantial effects on *Microcystis* abundance under the project alternatives, relative to Existing Conditions and the No Action Alternative. A qualitative evaluation was performed to determine if the action alternatives would result in an increase in frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta based on the following two additional abiotic factors that may affect *Microcystis*: 1) changes to water operations and creation of tidal and floodplain restoration areas that change water residence times within Delta channels, and 2) increases in Delta water temperatures.

The methodology used to determine residence time for Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 5, 6A, 6B, 6C, 7, 8, and 9 is described in BDCP Appendix 5.C, Section 5C.4.4.7, *Residence Time*. Briefly, residence time in different subregions of the Plan Area was assessed using the results of the DSM2 Particle Tracking Model for multiple neutrally buoyant particle release locations. Residence time was defined as the time at which 50% of particles from a given release location exited the Plan Area (either by movement downstream past Martinez or through entrainment at the south Delta export facilities, north Delta diversion, North Bay Aqueduct, or agricultural diversions in the Delta). The data were reduced into mean residence time by subregion and season. The data do not represent the length of time that water in the various subregions spends in the Delta in total, but do provide a useful parameter with which to compare generally how long algae would have to grow in the various subregions of the Delta. Table 8-60a shows the residence time results that are used in the *Microcystis* assessments. Results for summer and fall are most relevant for the *Microcystis* assessment, but all seasons are presented for completeness.

Table 8-60a. Average Residence Time for Subregions of the Plan Area by Season and Alternative

		Average Residence Time (days)										
Subregion	Season	Ex Cond.	No Act.	Alt 1	Alt 2	Alt 3	Alt 4 Scn H3	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
North Delta	Summer	33	38	43	38	41	39	41	43	40	46	40
	Fall	49	50	61	56	60	57	55	55	57	58	55
	Winter	36	37	40	40	40	39	41	37	37	37	40
	Spring	30	33	37	35	36	35	36	34	34	29	35
	Overall	35	38	43	41	43	41	41	40	40	40	41
Cache Slough	Summer	18	21	46	40	45	39	39	49	46	59	46
	Fall	46	46	44	39	43	40	39	39	45	56	39
	Winter	29	31	33	32	33	32	33	28	29	27	31
	Spring	22	24	33	33	33	33	33	31	30	33	31
	Overall	27	29	38	36	38	35	36	36	36	42	36
West Delta	Summer	22	24	32	28	30	28	29	40	27	33	28
	Fall	25	27	34	30	33	30	30	30	31	32	27
	Winter	18	20	21	21	21	21	21	19	19	19	19
	Spring	18	20	24	22	24	22	23	20	20	17	20
	Overall	20	22	27	25	26	25	25	27	23	24	23
East Delta	Summer	22	26	40	34	35	34	31	76	32	48	21
	Fall	15	35	33	47	32	48	48	58	55	55	21
	Winter	28	32	40	42	40	42	40	50	51	50	26
	Spring	42	47	57	54	59	54	56	61	57	54	35
	Overall	29	36	45	45	44	45	44	61	49	52	27
South Delta	Summer	8	10	16	17	14	16	11	70	23	33	35
	Fall	5	11	8	42	8	43	34	79	53	52	33
	Winter	10	11	19	19	14	16	15	59	57	56	28
	Spring	25	26	24	29	20	28	27	65	60	58	31
	Overall	13	16	18	26	15	25	21	67	49	50	32
Suisun Marsh	Summer	51	58	38	35	37	35	36	37	36	39	42
	Fall	17	19	39	34	38	34	33	32	34	34	38
	Winter	9	9	28	28	29	27	29	24	24	24	32
	Spring	45	51	32	31	31	30	30	29	28	25	33
	Overall	33	37	33	32	33	31	32	30	30	30	36

The methodology used to characterize residence time changes under Alternatives 4A, 2D, and 5A relied on modeled residence times presented in the Biological Assessment for the California WaterFix (ICF International 2016) for July through November. In addition, changes in maximum daily channel velocities, as modeled by DSM2, for a number of locations in the Delta were evaluated.

8.3.1.8 San Francisco Bay

The western seaward boundary of the Plan Area has been delineated at Carquinez Strait. There are no actions proposed to occur in the bays seaward of the Plan Area. Nevertheless, because a substantial portion of Delta waters does flow seaward, an assessment of the effects of Delta water quality changes under the project alternatives on the San Francisco Bay water quality was conducted to identify potential effects in the Bay. The assessment addresses potential direct and indirect effects on water quality of areas seaward of the Delta, based on the best available scientific understanding. No hydrologic or hydrodynamic modeling was conducted seaward of Suisun Bay.

Because net Delta flows move seaward, water quality constituents present in the Delta water column could potentially be transported seaward. The Screening Analysis (see Sections 8.3.1.3, 8.3.2.1, and Appendix 8C, *Screening Analysis*) identified constituents present in Delta waters warranting detailed assessment in the Plan Area based on their historical concentrations in the water column or importance to beneficial uses of Delta waters. These same constituents were addressed in the assessment of effects on San Francisco Bay. The assessment of effects in San Francisco Bay was based on projected changes in constituent concentration/levels that would occur in the Delta and changes in Delta outflow under the project alternatives. The following sections describe constituent-specific considerations and methods for calculating changes in Delta loading that are common to the assessment of all project alternatives in the San Francisco Bay for nutrients (ammonia, nitrate, and phosphorus), mercury, and selenium.

Nutrients: Ammonia, Nitrate, Phosphorus

Constituent-specific Considerations

Nutrients in freshwater outflows from the Delta have the potential to impact the embayments that make up the San Francisco Bay, although oceanic flows in and out of the Golden Gate mute the influence of Delta-derived freshwater flows on the Central Bay, South Bay, and Lower South Bay (Senn and Novick 2013). Thus, nutrients effects to San Francisco Bay from changes in Delta outflow would be limited almost entirely to the northern part of San Francisco Bay, namely San Pablo Bay. The assessment specifically addresses effects on San Pablo Bay, but relies on research conducted in Suisun Bay, because very little research specific to San Pablo Bay has been conducted and because San Pablo Bay and Suisun Bay experience similar nutrient loading. Existing effects from nutrients on San Pablo Bay and Suisun Bay have been hypothesized, yet widespread impairment due to nutrients in these embayments is not thought to be occurring (Senn and Novick 2013).

Suisun Bay is currently characterized by levels of phytoplankton biomass and a community composition insufficient to support the pelagic food web. The highly altered phytoplankton community and low biomass levels are thought to be linked primarily to the invasive clam *Corbula amurensis*, which was established in Suisun Bay in 1987, and grazing by other aquatic macroinvertebrates, specifically zooplankton (Kimmerer and Thompson 2014). Notwithstanding, Dugdale et al. (2007; 2012) has argued that nitrate is preferred by and fuels blooms of diatoms, and that uptake of nitrate by diatoms is impaired until ammonia levels are depleted below 0.03–0.06

mg/L-N. The onset of diatom blooms in Suisun Bay, and to a lesser extent San Pablo Bay, has been attributed to the drawdown of ammonia levels in these embayments. Ammonia levels are infrequently lower than this threshold. Currently, there is a lack of experimental results substantiating the ammonia-inhibition hypothesis and conflicting mechanistic interpretations of the available studies (Senn and Novick 2013; Senn and Novick 2014).

Other research has hypothesized that a high N:P ratio in the Delta and Suisun Bay has caused a transition away from a diatom-based food web, resulting in a cascading effect on higher trophic levels compared to conditions prior to the onset of phytoplankton biomass and community composition changes which occurred around 1986 (Glibert et al. 2011). As some have indicated, the introduction of C. amurensis is likely to have caused these alternations in phytoplankton biomass and composition (Senn and Novick 2014). The influence of a high N:P ratio on changes in chlorophyll levels and phytoplankton composition in Suisun Bay or downstream embayments receiving freshwater from the Delta cannot be ruled out, nor the magnitude of its effect determined. Nonetheless, these effects are likely to be small compared to the obvious and documented effects of the introductions of clams and copepods, which cannot reasonably be linked to nutrient conditions in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014).

Harmful algal blooms are considered a stressor of Suisun Bay. Summer-fall blooms of *Microcystis aeruginosa* have occurred with increasing frequency and intensity in the Delta and Suisun Bay since 2000. While blooms of *Microcystis* have not been documented in embayments downstream of Suisun Bay, the toxin produced by some *Microcystis* strains, microcystin, was detected in pilot monitoring measurements throughout the low salinity zone and in the central and southern embayments of San Francisco Bay (Senn and Novick 2014). In the San Francisco Estuary, nutrient levels are not considered a primary driver *Microcystis* bloom formation (Lehman et al. 2013); however, there is evidence that *Microcystis* tends to prefer an ammonia nitrogen source compared to other forms of nitrogen (Senn and Novick 2014).

Load Estimates

Effects of the project alternatives on nutrient loads to Suisun Bay and San Pablo Bay were determined by estimating the percentage change in phosphorus and nitrogen loads in Delta outflow due to the alternative. Because the project alternatives would not change net outflows between the upstream entrance of Suisun Bay (Mallard Island) and San Pablo Bay (Martinez or Carquinez Strait), nor would there be substantial changes in nutrient loading within Suisun Bay, estimated changes in loading to Suisun Bay were used as an approximation for the change in nutrient loading to San Pablo Bay. Changes in Delta-related nitrogen and phosphorus loads to Suisun Bay and San Pablo Bay were thus assumed to be proportional to the estimated change in loads in Delta outflow.

For nitrogen loads, changes of nitrate and ammonia loads at Mallard Island were estimated differently for Existing Conditions than for the project alternatives, due to differing assumptions regarding nitrogen loads from the SRWTP, the largest point source of nitrogen to the Delta. Loadings were estimated in the following manner.

Ammonia:

- Existing Conditions: The ammonia-nitrogen load was assumed to be equivalent to the current average ammonia load discharged from SRWTP (28.7 mg/L-N at 141 mgd; Sacramento Regional County Sanitation District 2014) plus the ammonia load of the Delta tributaries unaffected by the SRWTP discharge, calculated from the long-term average ambient ammonia concentration

(0.04 mg/L-N; Central Valley Regional Water Quality Control Board 2010a:5) and the Delta outflow (provided in Appendix 5A, Section C.7).

- Project Alternative: Ammonia-nitrogen loads at Mallard Island were calculated from the long-term annual ammonia concentration downstream of the SRWTP calculated in the Impact WQ-1 and the long-term average net Delta outflow (provided in Appendix 5A, Section C.7).

Nitrate:

- Existing Conditions: The estimated nitrate-nitrogen load was based on the modeled long-term annual average nitrate concentration at Mallard Island (as shown in Appendix 8J, *Nitrate*) and the long term average net Delta outflow. The SRWTP contribution was not factored separately as it was for ammonia, because nitrate levels under Existing Conditions are below analytical detection levels in SRWTP effluent.
- Project Alternative: Nitrate-nitrogen loads were calculated as the sum of the nitrate load from modeled long-term annual average nitrate concentration at Mallard Island (which does not account for an increase in SRWTP effluent nitrate) and the average net Delta outflow, and nitrate load due to an increase in nitrate discharged from SRWTP (6.7 mg/L-N at 181 mgd; Sacramento Regional County Sanitation District 2014).

These mass-balance calculations assume that transformation and loss of nitrogen species within the Delta are negligible.

Phosphorus loads under the project alternatives could be altered by two factors: 1) change in the source water fraction, and thus phosphorus concentration, of outflows from the Delta; and 2) an increase or decrease in Delta outflow. The major source waters to the Delta—San Joaquin River, Sacramento River, and San Francisco Bay—have similar dissolved phosphorus concentrations for the months April through October (Figure 8-56), but during December through March, higher dissolved phosphorus concentrations occur in the San Joaquin River compared to the Sacramento River and San Francisco Bay. Under the project alternatives, changes in the fraction of San Joaquin River water in the Delta outflow during December through March are projected. Considering the dissolved phosphorus concentrations of these sources, mass balance calculations show that for the relative change in source water fractions at Mallard Island, the magnitude of change in the dissolved phosphorus concentration of Delta outflows during these months would be negligible (<0.01 mg/L-P). Therefore, the relative change in phosphorus load in Delta outflow was considered to be proportional to the change in net Delta outflow.

Mercury

Constituent-specific Considerations

San Francisco Bay is impaired because mercury contamination is adversely affecting existing beneficial uses, including sport fishing, preservation of rare and endangered species, and wildlife habitat (San Francisco Bay Regional Water Quality Control Board 2013). Mercury concentrations in San Francisco Bay fish are high enough to threaten the health of humans who consume them, while concentrations in some bird eggs harvested from the shores of San Francisco Bay are high enough to account for abnormally high rates of eggs failing to hatch (San Francisco Bay Regional Water Quality Control Board 2013). Because of these concerns, a mercury TMDL was approved for San Francisco Bay in 2007. Beneficial uses of the Delta are similarly impaired due to methylmercury, and the Central Valley Water Board adopted the Delta Methylmercury TMDL in 2011 to address the impairment. The geographic scope of the San Francisco Bay TMDL includes Suisun Bay, San Pablo Bay, Central Bay, South Bay, and Lower South Bay. The assessment addresses the effects of the project alternatives on mercury and methylmercury loads from the Delta to San Francisco Bay downstream of Suisun Bay.

The bioavailability and toxicity of elemental mercury (from whatever primary source) are greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands, wetlands or bottom sediments. The dominant source of methylmercury that enters the aquatic food web of San Francisco Bay is the internal net production of methylmercury bay sediments (Davis et al. 2012). Historically, millions of pounds of inorganic mercury were used in gold mining operations within the San Francisco Bay watershed, and a large fraction of this mercury was washed downstream and accumulated in Bay sediment. The large pool of inorganic mercury currently contained in Bay sediments dominates the fraction converted to methylmercury and that accumulating the Bay's aquatic food web.

Exports from the Delta represent a sizable source of the overall mercury load to San Francisco Bay. The San Francisco Bay Mercury TMDL estimated that the Delta exported mercury at a rate of 440 kg/year to the Bay based on data from 2003 (San Francisco Bay Regional Water Quality Control Board 2006). David et al. (2009) estimated the Delta's mercury export as 260 kg/year based on sediment, flow, and mercury data from 1995 through 2006. The later estimation is recognized as the most reliable calculation of mercury exported from the Delta to date (San Francisco Bay Regional Water Quality Control Board 2006). Other sources contribute approximately 782 kg/year of mercury to San Francisco Bay, and include bed erosion, urban stormwater runoff, wastewater discharges, runoff from the Guadalupe River watershed and direct deposition (San Francisco Bay Regional Water Quality Control Board 2006).

Methylmercury loading to the waters of San Francisco Bay is estimated to be approximately 25 kg/year and is dominated by internal loading of methylmercury from Bay sediments (16 kg/year). External inputs account for approximately 8 kg/year of methylmercury loaded to the Bay, of which the Delta accounts for 3.6 kg/year (Yee et al. 2011).

The San Francisco Bay Water Board assigned a total mercury waste load allocation (WLA) for the Delta of 330 kg/year or a load reduction of 110 kg/year. The Central Valley Water Board has targeted the 110 kg/year total mercury load reduction in its planned implementation of the Delta Methylmercury TMDL (San Francisco Bay Regional Water Quality Control Board 2006). Waste load allocations for methylmercury were not established in the San Francisco Bay Mercury TMDL.

Load Estimates

Mercury and methylmercury loads were estimated by taking into account the change in existing load due to modifications in Delta outflow and changes in the fraction of source waters of Delta outflows to San Francisco Bay that would occur under the project alternatives. The existing loads of mercury and methylmercury from the Delta to San Francisco Bay of 260 kg/year and 3.6 kg/year, respectively, were obtained from the published literature (David et al. 2009; Yee et al. 2011). These loads were calculated using historical water quality and flow data from Mallard Island, and as such, they account for the many sources of mercury and methylmercury to Delta waters. In assessing the effects on mercury and methylmercury loads in Delta outflows due to the project alternatives, the approach taken assumes that the multiple other sources of mercury and methylmercury to net Delta outflow, besides changes in source water fraction and net outflow, would remain constant. This assumption was made because data was only available to quantitatively estimate the change in mercury and methylmercury loads due to changes in the magnitude of Delta outflow and changes in mercury and methylmercury concentrations at Mallard Island due to changes in source water fractions at that location. The project alternatives effects of floodplain and tidal restoration on methylmercury concentrations in the Delta, and thus, the San Francisco Bay were not quantifiable, and so were considered qualitatively in this analysis.

The long-term average mercury and methylmercury loads under the project alternatives were calculated as the sum of 1) the existing mercury and methylmercury loads from existing literature, and 2) the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables. The change in the mercury and methylmercury load in Delta outflow was calculated as follows. Long-term average concentrations of mercury and methylmercury in water were modeled quantitatively for the Delta using a mass-balance approach (as described in Appendix 8I, *Nitrate*). Concentration data represent the concentration expected at a given location due to conservative mixing (i.e., no uptake, loss or transformation) of the various source water fractions under the project alternatives. Thus, the estimated concentrations do not account for other sources of mercury and methylmercury to Delta waters, including mobilization of sediment, flux from sediment, and in-Delta mercury methylation. Given its seaward location, the modeled long-term average concentration data for Mallard Island (Appendix 8I, Table I-5 and Table I-6) were assumed to represent the concentration of mercury and methylmercury in Delta outflow due to changes in various source water fractions under the project alternatives. Modeled Mallard Island concentrations were converted to loads using the long-term annual average Delta outflow (as shown in Appendix 5A, Section C.7) at Mallard Island projected for Existing Conditions and the project alternative. The difference between the load estimate for the alternative and Existing Conditions is equivalent to the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables (item 2, above).

Long-term average mercury and methylmercury loads in Delta exports to San Francisco Bay were then estimated by summing 1) the existing load (260 kg/year mercury; and 3.6 kg/year methylmercury) and 2) the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables.

Selenium

Constituent-specific Considerations

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. It is also highly bioaccumulative and is of concern because at high levels it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf 2003). Examples of those effects include reduced hatchability of fertile eggs and the development of severe, often lethal, embryo deformities in fish and birds (US Department of Interior 1998; Ohlendorf 2003). Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the food chain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive receptors to selenium exposure. Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional non-habitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

Selenium is a constituent of concern in San Francisco Bay for potential effects on aquatic and terrestrial resources, and (indirectly) human health. The State Water Board listed San Francisco Bay as having impaired water quality for selenium under CWA Section 303(d) in 1998 (State Water Resources Control Board 2011). Currently, North, Lower, and South San Francisco Bay are Section 303(d) listed for impairments from selenium due to reduced hatchability in nesting diving birds. Historical monitoring of selenium in ducks, fish, and invertebrates in the northern part of San Francisco Bay revealed concentrations that could cause health risks to people and wildlife. More recent monitoring has shown that selenium tissue concentrations of diving ducks have declined to be within the normal background range and white sturgeon muscle concentrations are substantially lower than observed before the North Bay was Section 303(d) listed (San Francisco Bay Regional Water Quality Control Board 2011; San Francisco Estuary Institute 2014). Selenium levels in the North Bay have declined gradually since the early 1990s before the North Bay was first Section 303(d) listed (Tetra Tech 2008). This was due in part to the fact that petroleum refineries, which were a major source of dissolved selenium to the North Bay at that time, implemented controls by 1999 that decreased selenium in their discharges by up to 66% (Tetra Tech 2008).

Although the entire San Francisco Bay is listed as impaired by selenium, separate TMDLs for selenium will be developed for the North Bay and South Bay, as the primary selenium loading to the North Bay and the Suisun Bay area is from the Delta, while the South Bay is affected by local and watershed sources not associated with the Delta (Lucas and Stewart 2007). The San Francisco Bay Water Board is conducting a new TMDL project to address selenium toxicity in the North Bay, defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (San Francisco Bay Regional Water Quality Control Board 2011). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL also will quantify selenium loads, develop and assign waste load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

Of the major watersheds that contribute to outflow from the Delta to the North Bay, selenium is most enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley (Presser and Piper 1998). Erosion of the selenium-enriched sedimentary rock and irrigation practices used in the Central Valley contribute to selenium concentrations in this watershed.

The San Francisco Bay RMP collects samples throughout San Francisco Bay annually for measurement of total and dissolved selenium. The San Francisco Bay Water Board (2011) recommends averaging selenium concentrations from samples collected across the North Bay on an annual basis to compare with water column selenium numeric thresholds. Total and dissolved selenium data generated by the RMP during the period 2002–2013 for samples collected north of the Bay Bridge and downstream of Mallard Island were averaged for each calendar year (San Francisco Estuary Institute 2015). For dissolved selenium, annual average concentrations in the North Bay ranged from 0.05–0.17 μg/L, averaging 0.11 μg/L over the entire period. For total selenium, annual average concentrations in the North Bay ranged from 0.07–0.22 μg/L, averaging 0.13 μg/L over the entire period. The ratio of dissolved to total selenium over this period was 90%.

Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR (San Francisco Bay Regional Water Quality Control Board 2013). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 μg/L (4-day average) and 20 μg/L (1-hour average). By comparison, the available data show that the maximum concentration in the North Bay has not exceeded 0.44 µg/L since 2002. However, the NTR criteria are not considered protective of aquatic life in the San Francisco Bay because the current scientific information shows that selenium toxicity is driven by dietary exposures that are amplified through biomagnification of selenium through the aquatic food chain (U.S. Environmental Protection Agency 2014). The USEPA has published draft aquatic life ambient water quality criteria for selenium (U.S. Environmental Protection Agency 2014) that account for dietary exposure that recommend fish and fish egg/ovary tissue concentrations that are protective of aquatic life. The USEPA draft criterion for selenium is 15.2 mg/kg (dry weight) in fish eggs or ovaries, and 8.1 mg/kg (dry weight) in fish whole-body (or 11.8 mg/kg in fish muscle). Selenium concentrations in white sturgeon muscle throughout the entire San Francisco Bay, including fish from the North Bay, have mostly been below 10 mg/kg (dry weight) in the most recent fish surveys conducted by the RMP (San Francisco Estuary Institute 2014). Because obtaining fish tissues is challenging, USEPA (2014) also recommends water column dissolved selenium criteria of 1.3 µg/L for lentic aquatic systems and 4.8 µg/L for lotic aquatic systems. Water column dissolved selenium concentrations in the North Bay have been substantially below the draft lentic or lotic recommended criteria.

Because the North Bay TMDL is currently in development, a final fish-tissue concentration target and method for translating this target to a dissolved selenium water column concentration for the North Bay has not yet been determined. Presser and Luoma (2013) translated a whole-body fish tissue target of 8 mg/kg to a dissolved selenium water column concentration using ecosystem modeling and data/assumptions specific to the North Bay. In the North Bay, white sturgeon are considered representative of the most sensitive aquatic species because its exposure to selenium is high due to its long lifecycle, its benthic feeding habits, and its diet consisting of selenium-rich benthic macroinvertebrates (i.e., Corbula amurensis) (San Francisco Bay Regional Water Quality Control Board 2011). A dissolved selenium concentration of 0.202 µg/L, applicable to the North Bay as a whole, was predicted by Presser and Luoma (2013) to coincide with a whole-fish tissue concentration in white sturgeon of 8 mg/kg under long-term average annual flow conditions (trophic transfer factors for predator and prey were 1.3 and 9.2, respectively; partitioning coefficient (Kd) was 3,317 L/g).

Annual average dissolved selenium concentrations in the North Bay as measured by the RMP (0.05–0.17 µg/L) have been below the 0.202 µg/L dissolved selenium water column target since 2002. The low long-term average dissolved selenium concentration of the North Bay (0.11 µg/L) and data from recent fish tissue surveys have led to the suggestion that the North Bay may not currently be impaired with respect to selenium, and this suggestion has led to continued efforts as part of the North Bay TMDL development to determine the current effects to aquatic life from selenium in the North Bay (San Francisco Bay Regional Water Quality Control Board 2011).

Existing annual average selenium loads for the entire North Bay have been calculated based on measured concentrations of the major source waters to the North Bay, with concentrations measured in samples from Mallard Island used to estimate the load of total selenium exported from the Delta (San Francisco Bay Regional Water Quality Control Board 2011). The Preliminary Project Report for the North Bay selenium TMDL has reported the existing load of total selenium to the North Bay is 5,605 kg/year (assuming an average urban and non-urban runoff load of 595 kg/year). The existing total selenium load to the North Bay from the Delta is 3,940 kg/year, which comprises 70.3% of the entire North Bay load (San Francisco Bay Regional Water Quality Control Board 2011). While the entire North Bay load of dissolved selenium was not determined, the dissolved selenium load to the North Bay from the Delta has been estimated as 2,700 kg/year (S San Francisco Bay Regional Water Quality Control Board 2011; Tetra Tech 2014).

Load Estimates

The project alternatives would primarily influence selenium loads to the North Bay through diversion of Sacramento River water at the proposed north Delta intakes, with the diverted fraction being replaced by flows from the San Joaquin River, which are naturally enriched with selenium. Because relatively minimal changes (<10%) in long-term average net Delta outflow relative to the project alternatives are expected (Appendix 5A, Section C.7), tidal velocities, and thus sedimentation rates, in the Plan Area and North Bay are expected to remain unchanged. Thus, increased sedimentation of particulates, and associated selenium enrichment of North Bay sediments, due to changes in net Delta outflow is not expected. Any changes in sediment selenium levels that would occur in the North Bay would track the relative changes in selenium water column concentrations due to the alternative. Changes in North Bay water column selenium concentrations and loads due to the project alternatives were determined as follows.

The long-term average total and dissolved selenium concentrations in the North Bay under the project alternatives were estimated assuming that the current long-term average selenium concentrations of the North Bay (0.11 and 0.13 µg/L for dissolved and total selenium) would change in proportion to the change in the long-term average total selenium load of the North Bay. North Bay selenium loads were estimated by taking into account the change in existing load due to modifications in net outflow and source water fractions of Delta exports to the North Bay expected for the alternative. Specifically, the long-term average selenium load of the North Bay under the alternative was calculated as the summation of 1) the existing North Bay selenium load (5,605 kg/year), and 2) the incremental change in selenium load of net Delta outflow expected under the alternative.

The incremental change in selenium load in net Delta outflow under the project alternatives (item 2, above) was estimated as follows, assuming that loads to the North Bay besides those from the Delta would remain unchanged. First, the percentage change in selenium load in net Delta outflow was calculated using modeling results. Long-term average concentrations of dissolved selenium in water were modeled for the Delta using a quantitative mass-balance approach (as described in Appendix 8M, *Selenium*). Concentration data represent the concentration expected at a given location due to conservative mixing (i.e., no uptake, loss or transformation) of the various source water fractions under the alternative. Thus, the estimated concentrations do not account for other sources or sinks of selenium to Delta waters, including mobilization of sediment, flux from sediment, and sediment deposition. Given its seaward location, the modeled long-term average concentration data for the Mallard Island station (Appendix 8M, Tables M-9a and M-9b) were assumed to represent the concentration of dissolved selenium in Delta outflow due to conservative mixing of the various source waters under the alternative. Mallard Island concentration data were converted to selenium loads using the long-term annual average flow (as shown in Appendix 5A, Section C.7) at Mallard Island. The percentage change of the modeled selenium load (modeled percentage change") under the alternative relative to the modeled selenium load in Delta outflow under Existing Conditions was then calculated. The incremental change in total selenium load of net Delta outflow under the alternative (item 2, above) was calculated as the product of 1) the modeled percentage change in selenium load, and 2) the current estimate for existing long-term average total selenium loads from the Delta to the North Bay (3,940 kg/year).

8.3.2 Determination of Effects

The water quality effects of the action alternatives and the No Project Alternative, relative to Existing Conditions for CEQA, and of the action alternatives relative to the No Action Alternative for NEPA were determined consistent with the Methods for Analysis presented in the previous section, and are presented below. Additional discussion beyond that presented herein pertaining to the potential for water quality-related effects on fish and aquatic resources, human health, and agriculture are addressed in Chapter 11, *Fish and Aquatic Resources*; Chapter 25, *Public Health*; and Chapter 14, *Agricultural Resources*, respectively.

As discussed in greater detail in Chapter 5, *Water Supply*, Section 5.3.2, the NEPA No Action Alternative (LLT), which reflects an anticipated future condition in 2060 and 2025 (ELT), includes both sea level rise and climate change (changed precipitation patterns), and also assumes, among many other programs, projects, and policies, implementation of most of the required actions under both the December 2008 USFWS BiOp and the June 2009 NMFS BiOp. The NEPA effects analyses in this chapter reflect these No Action assumptions.

8.3.2.1 Screening Analysis and Results

This water quality analysis assessed the potential effects of implementing the various alternatives on 182 constituents (or classes of constituents). The initial analysis of water quality effects, referred to as the "screening analysis" in in the introduction to Section 8.3.1, *Methods of Analysis*, resulted in the following findings. Of the 182 constituents, 110 were determined to have no potential to be adversely affected by the alternatives to an extent to which adverse environmental effects would be expected. Historical data for these constituents showed no exceedances of water quality objectives/criteria in the major Delta source waters, were not on the State's 303(d) list in the affected environment, were not of concern based on professional judgment or scoping comments, and had no potential for substantial long-term water quality degradation. Consequently, no further analyses were performed for these 110 constituents. Conversely, further analysis was determined to be necessary for 72 constituents. Of these, 15 are addressed further in the Screening Analysis itself in Appendix 8C because they did not warrant alternative-specific analyses, and 1—temperature—is addressed in Chapter 11, *Fish and Aquatic Resources.* The remaining 56 constituents are addressed in the Environmental Consequences section, and are contained in the sections noted in Table 8-61.

In addition, *Microcystis aeruginosa*, a species of freshwater cyanobacteria, is addressed in the water quality assessment, due to potential adverse effects to beneficial uses of Delta waters, including water supply and aquatic life uses, as further described in Section 8.1.3.18.

As discussed in Section 8.3.1, *Methods for Analysis*, constituents that require analysis beyond that of the initial screening analysis, and that do not behave conservatively (e.g., degrade or are consumed in biochemical processes) within the system were further assessed qualitatively. Conversely, constituents that are primarily conserved (i.e., do not change) as they move through the system (e.g., dissolved salts) were candidates for further quantitative assessments, via comparisons of modeled scenarios that depict the Existing Conditions, No Action Alternative, and the action alternatives (Table 8-61).

Table 8-61. Water Quality Constituents for which Detailed Assessments are Performed

Constituents Carried Forward for Further Analysis	Quantitative[a]	Qualitative	Section of Environmental Consequences
Ammonia		X	Ammonia
Boron	DSM2+MB		Boron
Bromide	DSM2+MB/EC Ratios		Bromide
Chloride	DSM2+MB/EC Ratios		Chloride
Oxygen		X	Dissolved Oxygen
Conductance (EC)	DSM2-QUAL		Electrical Conductivity (EC)/TDS
Total Dissolved Solids		X	Electrical Conductivity (EC)/TDS
Mercury	DSM2+MB		Mercury
Microcystis		X	*Microcystis*
Nitrate	DSM2+MB	X	Nitrate
Nitrite		X	Nitrate
Nitrite + Nitrate		X	Nitrate
Organic Carbon	DSM2-QUAL		Organic Carbon (DOC/TOC)
Haloacetic acids[b]		X	Organic Carbon (DOC/TOC)
Trihalomethanes[c]		X	Organic Carbon (DOC/TOC)
Cryptosporidium		X	Pathogens
Escherichia coli		X	Pathogens
Organochlorine, Organophosphate, and Pyrethroid Pesticides[d]		X	Pesticides and Herbicides
Phosphorus		X	Phosphorus
Selenium	DSM2+MB		Selenium
Other Trace Metals[e]		X	Trace Metals
Total Suspended Solids		X	Turbidity and TSS
Volatile Suspended Solids		X	Turbidity and TSS
Turbidity		X	Turbidity and TSS

[a] DSM2+MB = Constituent was modeled via mass balance approach described in Section 8.3.1.3, *Plan Area* (i.e., DSM2 fingerprinting results coupled with historical source water quality data); EC Ratios = Constituent was modeled via EC to chloride and/or chloride to bromide ratios described in Section 8.3.1.3; DSM2-QUAL = Constituent was modeled directly using DSM2-QUAL.

[b] Dibromoacetic Acid (DBAA), dichloroacetic Acid (DCAA), trichloroacetic Acid (TCAA), total haloacetic acids

[c] Bromodichloromethane, bromoform, dibromochloromethane, total THMs

[d] Aldrin, BHC, BHC-alpha, BHC-beta, BHC-delta, BHC-gamma (lindane), chlordane, chlorpyrifos, diazinon, dieldrin, endosulfan (mixed isomers), endosulfan-I, endosulfan-II, endrin, heptachlor, p,p'-DDD, p,p'-DDE, p,p'-DDT, toxaphene, pyrethroids

[e] Aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc, aluminum, silver

8.3.2.2 Comparisons

For hydrologic (i.e., CALSIM) modeling purposes, which depicts CVP and SWP system-wide operations and thus how water would be routed through the Delta, Existing Conditions, the No Action Alternative and the action alternatives were partly defined according to the key inputs shown in Table 8-62. For the quantitative and qualitative assessments performed, comparisons of the assessment scenarios were made consistent with Table 8-63 and are presented in Section 8.3.3, *Effects and Mitigation Approaches*. The CEQA baseline, "Existing Conditions", is defined in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and for the purposes of the quantitative water quality assessments is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented in Section 8.1.3, *Existing Surface Water Quality*. The No Action Alternative is defined by the future surface water demands at the 2025 level of development, and specific future planned and approved facilities and operations described in Appendix 3D. In addition, two planning horizons for projected climate change and sea level rise are provided, one at 2025 (ELT) and the other at 2060 (LLT). The longer planning horizon to 2060 for climate change is assumed for the No Action Alternative (LLT) compared to system water supply and demands to be commensurate with the 50-year implementation timeframe for the action alternatives that include HCP/NCCP components (i.e., Alternatives 1A-1C, 2A-2C, 3, 4, 5, 6A-C, 7, 8, and 9). The shorter planning horizon to 2025 – the ELT scenario -- is assumed for the alternatives that do not include HCP/NCCP components (i.e., Alternatives 2D, 4A, and 5A).

Table 8-62. Water Quality Assessment Scenarios

Input Parameters	Existing Conditions	No Action Alternative	Project Alternatives
Surface Water Demands[a]	2005/Recent Historical	2025/Full Water Rights	2025/Full Water Rights
Conveyance	Through Delta	Through Delta	Various
CVP/SWP Operational Criteria	Per USFWS and NMFS BiOps RPAs[b]	Per USFWS and NMFS BiOps RPAs[b]	Various
Fall X2	No	Yes	Some Yes, Some No
Climate Change/Sea Level Rise	None	Year 2060 (LLT) Year 2025 (ELT)	Year 2060 (BDCP alternatives) Year 2025 (non-HCP alternatives)

[a] This is a simplified characterization of the water demands to illustrate the differences between the scenarios. Water demands for some purveyors under the No Action and action alternatives are the same as those under Existing Conditions, while others are increased to a full contract amount or 2030 level. See CALSIM II modeling assumptions for specific differences (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*).

[b] U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) Biological Opinions (BiOps) Reasonable and Prudent Alternatives (RPAs) are described in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions,* and Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*.

Table 8-63. Scenario Comparisons Performed for Impact Assessment Purposes

Comparison		Purpose of Comparison
1	Existing Conditions versus Alternatives (including No Action Alternative)	A required comparison to current conditions for CEQA purposes. Shows effects due not only to changes in conveyance facilities and operational criteria defined by the alternative, including meeting Fall X2, but also the effects of future surface water demands and climate change/sea level rise.[a]
2	No Action Alternative versus Project Alternatives	Identifies potential alternative-specific effects caused by changes in conveyance facilities and operating criteria.

[a] The CEQA baseline, "Existing Conditions", is defined in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and for the purposes of quantitative water quality assessments, is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented in Section 8.1.3, *Existing Surface Water Quality*.

8.3.2.3 Effects Determinations

Both qualitative and quantitative water quality assessments have been conducted to determine the anticipated changes in water quality that may occur throughout the affected environment from implementing an alternative, relative to the water quality conditions that would occur under the Existing Conditions or the No Action Alternative. The water quality effects of the action or alternative would be adverse (under NEPA) and significant (under CEQA) if implementation of an alternative would result in one of the numbered conditions below. As defined and used for assessment purposes, these conditions serve as both effects criteria under NEPA and thresholds of significance under CEQA. As is explained in more detail below, the thresholds build on, and add detail to, general questions posed in the sample Initial Study checklist found in Appendix G to the CEQA Guidelines. The refinements to the language set forth in that document reflects the application of professional judgment and experience to the more general language found in the original.

1. Cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (applicable objectives/criteria are identified in Appendix 8A, *Water Quality Criteria and Objectives*, and the constituent-specific assessments in Section 8.3.1.7, *Constitute-Specific Considerations Used in the Assessment*), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies.

2. Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected water body (or portion of a water body) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.

3. Cause long-term degradation of water quality in one or more water body of the affected environment, resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses.

4. Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that are already impaired and, thus, included on the State's Clean Water Act

Section 303(d) list for the water body, such that beneficial use impairment would be made discernibly worse.

5. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.

The third effect assessment criterion/threshold listed above is triggered not by increased exceedances of water quality standards or adverse impacts on beneficial uses, but rather by the more sensitive threshold of demonstrated water quality degradation, on a long-term basis, that eliminates a substantial amount of the receiving water body's available assimilative capacity, thereby resulting in water quality conditions that substantially increase the likelihood of water quality objectives/criteria exceedances and adverse effects to beneficial uses. This effects assessment criterion/threshold would not be met if a substantial amount of available assimilative capacity is used under the alternative assessed, yet substantial assimilative capacity remains such that exceeding water quality objectives/criteria would be rare, if it were to occur at all and, therefore, resulting water quality poses negligible risk for adverse effects to beneficial uses.

Similarly, the fourth effect assessment criterion/threshold above is met not by demonstrated or potential adverse effects to beneficial uses, but rather the more sensitive criteria/threshold of "measurable degradation," on a long-term basis, under already impaired conditions. This effect assessment criterion/threshold is included in recognition that an adverse effects determination should be more sensitive when water quality conditions are already impaired in a water body and, therefore, any measurable worsening, on a long-term basis, may be considered substantial and adverse. This fourth effects assessment criterion/threshold provides meaningful sensitivity for already impaired conditions by requiring measurable changes, on a long-term basis, rather than "any" change at any time (i.e., a change that could be calculated, but may not be measureable in the actual environment, or may not occur frequently enough to measurably alter water quality on a long-term basis).

The fifth effect assessment criterion/threshold listed above applies to alteration of drainage patterns, which occurs through construction of various components of the project. Consequently, effects of the project were assessed relative to this criterion/threshold fully in the sections relating to effects of construction only.

As indicated above, these thresholds/criteria set forth above were derived from questions relating to hydrology and water quality in Appendix G (Section IX) of the CEQA Guidelines. Without refinements, thresholds derived literally from that source would read as follows:

- Violate any water quality standards (criterion 1);
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site (criterion 5);
- Otherwise substantially degrade water quality (criteria 3 and 4).

Appendix G thresholds of significance relating specifically to hydrology and flooding, and whether the project would substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site, are addressed in Chapter 6, *Surface Water*. The above-listed Appendix G thresholds have been integrated into the five numbered effects criteria/thresholds listed above and the applicable water quality objectives/criteria are identified in Appendix 8A, *Water Quality Criteria and Objectives*, and in Section 8.3.1.7, *Constitute-Specific Considerations Used in the Assessment*.

The first bulleted Appendix G threshold, "violate any water quality standard," was refined for application in effects criterion/threshold #1. This is because a "water quality standard" contains three components: 1) the beneficial uses of the water body to be protected, 2) the criteria/objectives that, when met, result in water quality protective of the designated beneficial uses, and 3) an antidegradation policy. Therefore, effects criterion/threshold #1 started with the basic concept behind this first Appendix G threshold, and was further refined to account for the frequency, magnitude, and geographic extent with which a water quality criterion or objective could be exceeded, thereby giving the assessor the ability to relate such exceedances to adverse effects on beneficial uses (i.e., actual adverse environmental effects). As such, effects criterion/threshold #1 will identify significant impacts under CEQA when water quality under an alternative is anticipated to change substantially, thereby causing adverse effects to beneficial uses, and will avoid making such determinations when the violation of a water quality standard is too infrequent, low in magnitude, and/or isolated geographically to actually cause any adverse effects on beneficial uses of the water body or water body segment.

Similarly, the third bulleted Appendix G threshold of "… substantially degrade water quality," is vague as written and thus not sufficiently specific to allow meaningful or precise application as a threshold of significance. Therefore, it too has been refined and expanded into effects criteria/thresholds #3 and #4 enumerated above.

Finally, the second bulleted CEQA Appendix G threshold has been included directly as effects criterion/threshold #5. Consequently, the applicable water quality thresholds of significance identified in Section IX of Appendix G of the CEQA Guidelines have been fully incorporated into the five numbered effects criteria/thresholds used to assess the identified water quality changes under the alternatives for the purposes of making impact determinations for CEQA purposes.

8.3.3 Effects and Mitigation Approaches

8.3.3.1 No Action Alternative

Pursuant to the description of comparisons made in this chapter, which are discussed in Section 8.3.2.2, this section contains the comparison of the No Action Alternative vs. Existing Conditions for CEQA purposes.

Under the No Action Alternative, the facilities and operations of the SWP and CVP would continue to be similar to Existing Conditions with the following changes.

- Effects of sea level rise and climate change on system operations.
- An increase in demands and the buildout of facilities associated with water rights and CVP and SWP contracts of about 443 thousand acre-feet per year (TAF/year), north of Delta at the future level of development. This is an increase in CVP municipal and industrial (M&I) service contracts (253 TAF/year) and water rights (184 TAF/year) related primarily to urban M&I use, especially in the communities in El Dorado, Placer, and Sacramento Counties.
- An increase in demands associated with SWP contracts, up to full contract amounts, south of Delta at the future level of development. SWP M&I demands, which under the existing level of development vary on hydrologic conditions between 3.0 and 4.1 MAF per year, under the future

condition are at maximum contract amounts in all hydrologic conditions. This represents a potential 25% increase on average in south of Delta demands under SWP M&I contracts between existing and future levels of development due to assumed additional development and demographics.

- New urban intake/Delta export facilities:
  - Freeport Regional Water Project (see Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix,* for information on additional East Bay Municipal Utility District (EBMUD) demand of about 26 TAF/year on the average with increased demand in dry years)
  - 30 million-gallon-per-day City of Stockton Delta Water Supply Project
  - Delta-Mendota Canal–California Aqueduct Intertie
  - Contra Costa Water District Alternative Intake and 55 TAF/year increased demand
  - South Bay Aqueduct rehabilitation, to 430 cubic feet per seconds (cfs) capacity, from the junction with California Aqueduct to Alameda County Flood Control and Water Conservation District Zone 7.
- An increase in supplies for wildlife refuges including Firm Level 2 supplies of about 8 TAF/year at the future level of development. In addition, there is a shift in refuge demands from south to north (24 TAF/year reduction in south of Delta and 32 TAF/year increase in north of Delta).
- Implementation of the Fall X2 Reasonable and Prudent Alternative (RPA) action (see Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*), which requires maintenance of X2 at specific locations in wet and above normal years in September and October, plus releases in November to augment Delta outflow dependent on hydrology.

A detailed description of the modeling assumptions associated with the No Action Alternative is included in Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix.*

Note that the numbering of water quality impacts for the No Action Alternative, presented below, is consistent with the numbering of impacts for the action alternatives, For the action alternatives, two numbered impacts are provided for each constituent or constituent class, one for impacts due to water conveyance facilities operations and maintenance, and the other for impacts due to implementation of conservation measures under BDCP alternatives or Environmental Commitments under HCP alternatives. For the No Action Alternative, only discussion of impacts due to water conveyance facilities operations and maintenance is applicable. Therefore, only one numbered impact for each constituent or constituent-class is provided for the No Action Alternative, consistent with the numbering for the action alternatives' water conveyance facilities operations and maintenance impacts.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. Any negligible changes in ammonia-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to ammonia.

Delta

As summarized in Table 8-40, under the No Action Alternative, it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia concentration would not exceed 1.5 mg/L-N in April through October and 2.4 mg/L-N in November through March. In comparison, the permitted average monthly effluent ammonia concentration under the Existing Conditions is 33 mg/L-N, with actual monthly average ammonia concentration in the effluent being approximately 24 mg/L-N (Central Valley Regional Water Quality Control Board 2010e). Because of this, ammonia concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under the No Action Alternative, relative to Existing Conditions. As shown in Figure 8-52, Sacramento River ammonia concentrations currently are of the same magnitude as San Joaquin River and San Francisco Bay concentrations of ammonia during the January through March period of the year, and much greater than these two sources for the remainder of the year. Consequently, a substantial decrease in Sacramento River ammonia concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Additionally, San Joaquin River and San Francisco Bay concentrations are similar to each other throughout the year (Figure 8-52), indicating that any change in source water fraction from BAY to SJR or from SJR to BAY at locations in the Delta would not substantially alter concentrations at these locations. Therefore, at locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged. Any negligible increases in ammonia-N concentrations that may occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D, *Source Water Fingerprinting Results*). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia concentrations are expected to decrease under the No Action Alternative, relative to Existing Conditions. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

In summary, based on the discussion above, effects on ammonia of facilities operations and maintenance are considered to be not adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under the No Action Alternative, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under the No Action Alternative, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent from ammonia that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-3: Effects on Boron Concentrations Resulting from Existing Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Because substantial sources of boron do not exist upstream of the Delta in the watersheds of the Sacramento River and eastside tributaries, concentrations of boron in surface water are low and often below detection limits (see Section 8.1, *Environmental Setting/Affected Environment*). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on boron sources, and ultimately the concentration of boron in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to cause exceedance of boron objectives or substantially degrade water quality with respect to boron and thus, would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of boron. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of boron, loading in the lower San Joaquin watershed contributes to relatively high concentrations which can be sourced to agricultural irrigation of soils containing boron and use of water imported from the south Delta. Average boron concentrations in the lower San Joaquin River at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% relative to Existing Conditions (as a result of climate change and increased water demands) (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Based on best-fit regressions of annual average San Joaquin River flow and boron, these decreases in flow would correspond to a potential increase in long-term average boron of about 2% relative to Existing Conditions (Appendix 8F, Table Bo-32). The relatively small increase would not cause boron concentrations to exceed applicable objectives relative to Existing Conditions and would not cause substantial long-term water quality degradation with regards to boron. Accordingly, with respect to the 303(d) listing of the lower San Joaquin River impairment for boron would not be made discernibly worse. The No Action Alternative also would not be expected to adversely affect necessary TMDL actions implemented to reduce boron loading in the lower San Joaquin River because the modeled increases are associated with less dilution of the existing load and boron loading would not be anticipated to change measurably. Consequently, the small increases in lower San Joaquin River boron levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to Existing Conditions, the No Action Alternative would result in generally similar long-term annual average boron concentrations, or decreased average concentrations, at ten of the eleven Delta assessment locations for the 16-year period modeled (i.e., 1976–1991), and would increase only at the Jones Pumping Plant location by about 3% (Appendix 8F, Table Bo-2). Increased monthly average concentrations would occur under the No Action Alternative at nine of the assessment locations during the months of December through June, with decreased or similar concentrations occurring only at two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). For the drought year period modeled (i.e., 1987–1991), the No Action Alternative would result in increased annual average concentrations at six locations (up to a maximum 4% increase at the Jones Pumping Plant) relative to Existing Conditions.

With respect to the 2,000 μg/L EPA drinking water human health advisory objective (i.e., for children), the long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, are low and would never exceed this objective at any of the eleven Delta assessment locations under the No Action Alternative (i.e., maximum long-term average concentration of about 417 µg/L at the Sacramento River at Mallard Island), which represents a slight decrease from the Existing Conditions (Appendix 8F, Table Bo-3A). Long-term average boron concentrations would be similar or slightly lower at most Delta assessment locations, and no changes would result in measureable long-term use of assimilative capacity (i.e., less than 3% reduction) or further degradation of water quality conditions with respect to the 2,000 µg/L objective (Appendix 8F, Table Bo-4). Consequently, boron levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal water supply beneficial uses of the Delta.

Similarly, under the No Action Alternative, the long-term annual average and monthly average boron concentrations for either the 16-year period or drought period modeled would never exceed the lowest agricultural objective of 500 µg/L contained in the San Francisco Bay RWQCB (Region 2) Basin Plan at any Delta assessment location except at the Sacramento River at Mallard Island and San Joaquin River at Antioch locations (Appendix 8F, Table Bo-3A). However, the agricultural beneficial use is not an existing designated use at Mallard Island within the Region 2 Basin Plan, and the Antioch location is in the far western Delta and not a location of agricultural diversions (California Department of Water Resources 1995). Small reductions in the modeled long-term average assimilative capacity would occur only at the Jones and Banks pumping plants, Old River at Rock Slough, and Sacramento River at Emmaton locations (e.g., maximum reduction of 3% at Jones Pumping Plant for both the 16-year and 4% for the modeled drought period) (Appendix 8F, *Boron*, Table Bo-5). Moreover, the reduced assimilative capacity would not lead to an increased frequency of exceedances of objectives because the absolute concentrations would be well below the lowest 500 µg/L objective for the protection of agricultural beneficial uses, as indicated in plots of monthly average boron concentrations for representative interior and south Delta locations (i.e., Franks Tract, Old River at Rock Slough, Jones Pumping Plant, and Old River at Tracy Road) (Appendix 8F, Figure Bo-2). Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal or agricultural water supply beneficial uses of the Delta, or substantially degrade water quality with respect to boron.

SWP/CVP Export Service Areas

Under the No Action Alternative, relatively small increases would occur in long-term average boron concentrations at the Jones and Banks pumping plants relative to the Existing Conditions (i.e., up to 4% at Jones pumping plant for both the 16-year and drought period modeled) (Appendix 8F, Table Bo-2). With respect to the 303(d) listing of the lower San Joaquin River impairment for boron, increased boron concentrations in exported water to the San Joaquin River basin could lead to increased loading in the lower San Joaquin River since boron is principally related to irrigation water deliveries. However, the absolute average boron concentrations at Jones Pumping Plant would be low relative to applicable objectives (Appendix 8F, Figure Bo-2), and the reduction in assimilative capacity would be minor (i.e., 4% reduction for the drought period modeled) compared to the Existing Conditions (Appendix 8F, Table Bo-5). Thus, the long-term increased boron concentrations would not be expected to cause further measurable degradation in the lower San Joaquin River that would make the existing impairment discernibly worse or adversely affect necessary TMDL actions implemented to reduce boron loading. Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal or agricultural water supply beneficial uses in the SWP and CVP service area, or substantially degrade water quality with respect to boron.

In summary, the effects of additional future climate change/sea level rise under the No Action Alternative conditions would result in relatively small increases in long-term average boron concentrations in the lower San Joaquin River and several Delta locations. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, the No Action Alternative would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increase in boron concentrations upstream of the Delta in the San Joaquin River watershed.

It is expected there would be no substantial change in Delta boron levels (i.e., <4% increase at any assessment location) in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies. With respect to the 303(d) listing of boron in the lower San Joaquin River for the agricultural water supply beneficial use, the potential small increase in long-term average boron concentration associated with reduced flows and exported water at the Jones Pumping Plant would not be expected to cause substantial additional boron loading, or further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment to be discernibly worse.

Boron is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, the No Action Alternative would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under the No Action Alternative would not be of sufficient magnitude to cause substantially increased risk of exceeding objectives or adverse effects to municipal or agricultural beneficial uses, or any other beneficial uses, within the affected environment. Based on these findings, this impact is determined to be less than significant.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to Existing Conditions. As shown in Table 8-43, the Sacramento River watershed and eastside tributaries are negligible sources of bromide to the Delta.

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of bromide. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of bromide, bromide on the lower San Joaquin is relatively high and can be sourced to agriculture irrigation water imported from the southern Delta. Agricultural irrigation drainage is the primary source of bromide on the lower San Joaquin River, where concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% relative to Existing Conditions (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Based on best-fit regressions of annual average San Joaquin River flow and bromide, these decreases in flow would correspond to a possible increase in long-term average bromide of about 3% relative to Existing Conditions (Appendix 8E, *Bromide*, Table 24). The relatively small magnitude of this increase is considered to be less than substantial. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River bromide levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to Existing Conditions, the No Action Alternative would result in small decreases in long-term average bromide concentrations at all modeled Delta assessment locations with the exception being the Sacramento River at Emmaton for the drought period (Appendix 8E, *Bromide,* Table 2). Long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2 operations, while Existing Conditions does not (Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on bromide is generally greater than sea level rise. For the modeled drought period, long-term bromide concentrations at Emmaton are predicted to increase by about 8%.

The modeled frequency with which bromide concentration exceeds 50 and 100 μg/L would change only slightly at all 11 assessment locations, with some Delta assessment locations experiencing improved water quality relative to bromide (Appendix 8E, *Bromide*, Table 2). However, small increases in modeled concentration threshold exceedances would occur at some Delta interior and western Delta assessment locations. In the Delta interior at Rock Slough and Franks Tract, the frequency of exceeding 100 μg/L would increase by a maximum of about 3 percentage points (4 percentage points for modeled drought period). Larger increases would occur in the western Delta, however, where the frequency of exceeding 100 μg/L would increase by as much as 7 percentage points at Emmaton (2 percentage points for modeled drought period). The greater frequencies of exceedance can be sourced primarily to the assumptions of sea level rise in the late long-term. While the greater influence of sea water would result in slightly more frequent bromide conditions exceeding 50 and 100 µg/L in these select interior and western Delta locations, the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Given these seasonal constraints on use, mass balance modeling predicts that use of these intakes would most frequently occur during the months of February, March, and April of wet and above normal water year types when water quality suitable for diversion would be most typically available. Focusing on this period of most likely seasonal use (February–April of wet and above normal water years), under the No Action Alternative average bromide concentrations would increase about 5% at the City of Antioch intake and would decrease about 4% at the Mallard Slough intake relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Such a relatively small predicted increase in bromide concentrations at the City of Antioch intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, while decreases at Mallard Slough would be considered beneficial.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Tables 3 and 26).

SWP/CVP Export Service Areas

Under the No Action Alternative, long-term average bromide concentrations at the Banks and Jones pumping plants would decrease by as much as 13% relative to Existing Conditions (Appendix 8E, *Bromide,* Table 2). As explained above for the Delta, long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on bromide is generally greater than sea level rise. The frequency with which bromide would exceed bromide concentration thresholds at the Banks and Jones pumping plants, relative to Existing Conditions, would remain unchanged or would improve slightly, including years of drought (Appendix 8E, *Bromide*, Table 2). Consequently water exported into the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regards to bromide under the No Action Alternative, relative to Existing Conditions.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 3).

Maintenance of SWP and CVP facilities under the No Action Alternative would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, the No Action Alternative would result in small decreases in long-term average bromide concentrations at all modeled Delta assessment locations with the exception being the Sacramento River at Emmaton for the drought period. For the modeled drought period, long-term bromide concentrations at Emmaton are predicted to increase by about 8%. Small increases in modeled concentration threshold exceedances would occur at some Delta interior and western Delta assessment locations, including Rock Slough, Franks Tract, and Emmaton, but the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. Moreover, the small (i.e., ≤5%) predicted increase in long-term average bromide concentrations at the City of Antioch intake would not be expected to adversely affect MUN beneficial uses while decreases at Mallard Slough would be considered beneficial.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Long-term average bromide concentrations at the Banks and Jones pumping plants are predicted to decrease by as much as 13% relative to Existing Conditions while exceedance of bromide concentration thresholds at the Banks and Jones pumping plants, would remain largely unchanged.

Based on the above, the No Action Alternative would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. The No Action Alternative would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 µg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 µg/L assessment threshold concentration would be 7 percentage points or less at all locations assessed, which is considered to be less-than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the No Action Alternative would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect an existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Because substantial sources of chloride do not exist upstream of the Delta, concentrations of chloride in surface water are low and often below detection limits (see "Section 8.1, *Environmental Setting/Affected Environment*). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on chloride sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River has generally elevated chloride concentrations compared to the Sacramento River and east side tributaries; however, average monthly and maximum concentrations are below the applicable drinking water MCL of 250 mg/L and the EPA chronic aquatic life criterion of 230 mg/L (Appendix 8G, *Chloride*, Table Cl-2). The chloride in the lower San Joaquin River can be sourced to accumulation of salts in agricultural drainage from irrigation water imported from the southern Delta. Chloride concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by the flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease by an estimated 6% relative to Existing Conditions (as a result of climate change and increased water demands). Based on best-fit regressions of annual average San Joaquin River flow and chloride, these decreases in flow would correspond to a potential increase in long-term average chloride concentrations of about 2% relative to Existing Conditions (Appendix 8G, Table Cl-62). The relatively small increase would not cause chloride concentrations to exceed applicable objectives relative to existing concentrations and would not cause substantial long-term water quality degradation with regards to chloride. Moreover, there are no existing municipal supply intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River chloride levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to Existing Conditions, modeling predicts that the No Action Alternative would result primarily in small decreases in long-term average chloride concentrations for the 16-year period modeled (i.e., 1976–1991) at all Delta assessment locations (Appendix 8G, Table Cl-1 and Table Cl-2). Long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Appendix 5A, *BDCP/California*

WaterFix FEIR/FEIS Modeling Technical Appendix). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on chloride is generally greater than sea level rise. In the months of February through June, monthly average chloride concentrations would increase at all of the assessment locations except two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). For the other months of the year (i.e., July through January), the changes in chloride concentrations would be variable with increases and decreases occurring at all eleven assessment locations. The Sacramento River at Emmaton location in the western Delta would exhibit the largest seasonal increases compared to Existing Conditions, ranging from 11% to 48% during the months of December through June. For the drought year period modeled (i.e., 1987–1991), the annual average chloride concentration would remain unchanged or decrease at ten of the assessment locations, but increase by about 12% compared to Existing Conditions at the Sacramento River at Emmaton location (Appendix 8G, Table Cl-1 and Table Cl-2). The comparison to Existing Conditions reflects changes in chloride due to both increased demands and changed hydrology and Delta hydrodynamic conditions associated with climate change and sea level rise. The following outlines the modeled chloride changes relative to the applicable objectives and effects on beneficial uses in Delta waters.

Municipal and Industrial Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For No Action Alternative, the modeled frequency of objective exceedance would decrease relative to Existing Conditions. The modeled frequency of exceedance is predicted to be 7% under Existing Conditions and 0% under the No Action Alternative (Appendix 8G, Table Cl-64). Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For the No Action Alternative, the modeled frequency of objective exceedance would decrease slightly, from 6% of modeled days under Existing Conditions, to 4% of modeled days under the No Action Alternative (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3, *Plan Area*), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach, modeled monthly average chloride concentrations at the Barker Slough at North Bay Aqueduct for the 16-year period would not exceed the objective, which represents no change from the Existing Conditions (Appendix 8G, *Chloride*, Table Cl-3). The modeled frequency of exceedances at the Banks pumping plant would decrease slightly from 4% under Existing Conditions to 2%. At the Contra Costa Canal at Pumping Plant #1, the modeled frequency of exceedances of this objective would decrease about 10% from 24% to 14%. Chloride concentrations in the western Delta can exceed the applicable 250 mg/L objective frequently in the low-flow fall and early winter months under Existing Conditions. Consequently, water is diverted from the San Joaquin River at Antioch and Mallard Slough municipal intakes only when salinity conditions are acceptable. The frequency of exceedances of the objective at the San Joaquin at Antioch location for the 16-year period modeled would increase from 66% under Existing Conditions to 73% for a net increase of about 7% and would increase 1% (i.e., from 85% under Existing Conditions to 86%) at the Sacramento River at Mallard Island location. Moreover, the increased chloride concentrations would occur during the months of January through June, thus reducing water quality during the period of seasonal municipal diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 39% for the 16-year period modeled and 97% for the drought period only) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Table Cl-5).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity are similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Table Cl-4). Based on the additional predicted seasonal and annual exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation and use of assimilative capacity, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Antioch location, through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

Tom Paine Slough in the southern Delta is on the 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. The plot of monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would be well below the MCL and generally would be similar, or reduced slightly, compared to Existing Conditions (Appendix 8G, Figure Cl-2).

Suisun Marsh is on the 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. The Sacramento River at Mallard Island, Sacramento River at Collinsville, and Montezuma Slough at Beldon's Landing within the marsh, are DSM2-modeled locations representative of source water quality conditions for the marsh that is supported by inflowing flood tide waters from the west, and ebb tide flows of Sacramento River water into Montezuma Slough through the SMSCG located near the Collinsville location. Long-term average chloride concentrations at the Sacramento River at the Mallard Island location for the 16-year period modeled would decrease slightly by 140 mg/L (-5%) compared to Existing Conditions (Appendix 8G, Table Cl-1). The plots of monthly average chloride concentrations for the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3) and Montezuma Slough at Beldon's Landing (Appendix 8G, Figure Cl-4) for the 16-year period modeled indicate that, compared to Existing Conditions, chloride concentrations would be similar or lower during the months of October through May. Consequently, chloride concentrations at Tom Paine Slough and Suisun Marsh would not be further degraded on a long-term basis or adversely affect necessary actions to reduce chloride loading for any TMDLs developed.

SWP/CVP Export Service Areas

Under the No Action Alternative, long-term average chloride concentrations at the Banks and Jones pumping plants would decrease by as much as 12% relative to Existing Conditions for the 16-year period modeled (Appendix 8G, *Chloride*, Table Cl-1). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease at the Banks and Jones pumping plants, relative to Existing Conditions for both the 16-year period modeled and the drought period (Appendix 8G, *Chloride*, Table Cl-3). As explained above for the Delta, long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on chloride is generally greater than sea level rise. Consequently, water exported into the SWP and CVP service area would generally be of similar or slightly better quality with regards to chloride under the No Action Alternative relative to Existing Conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-2 and Table Cl-4).

Maintenance of SWP and CVP facilities under the No Action Alternative would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any beneficial uses would be adversely affected anywhere in the affected environment.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the No Action Alternative would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

It is expected there would be substantial changes in Delta chloride levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies. Relative to Existing Conditions, the No Action Alternative would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 7%) and at Mallard Slough (by 1%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. With respect to the 303(d) listings, the small increases in average chloride concentrations would not cause further degradation on a long-term basis that would adversely affect necessary actions to reduce chloride loading for any TMDLs developed for Tom Paine Slough and Suisun Marsh wetlands.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative would not result in adverse chloride bioaccumulation effects to aquatic life or humans. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and objective exceedances, and additional long-term degradation, in the western Delta and associated effects on the municipal and industrial water supply beneficial uses.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance

Upstream of the Delta

DO levels in the reservoirs and rivers are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

A reservoir can exhibit seasonal changes in the DO profile from the water surface to the sediments that is affected by its degree of thermal stratification, where oxygenated inflows enter and mix with the reservoir, its level of productivity that contributes DO through photosynthesis and consumes DO through respiration and decomposition, as well as the prevailing winds that cause mixing within the reservoir. Water temperature also is a factor in that it affects the level (between the surface and the bottom) at which oxygenated river inflows enter the reservoir, the DO saturation level, and photosynthesis and respiration rates. Cold inflows tend to move deep into the reservoir due to the lower density of cold water, whereas warm water inflows tend to mix with the surface waters, particularly when the reservoir is thermally stratified. Under the No Action Alternative, the primary factor that would change relative to Existing Conditions is that end-of-September carryover storage would be lower in all years (see Chapter 5, *Water Supply*, Section 5.3.3.1), which would affect the temperature profile of the reservoirs at the end of summer. Nevertheless, the reservoirs would continue to thermally stratify seasonally, as they do under Existing Conditions. Given the size of the reservoirs—Lake Oroville, Trinity Lake, Shasta Lake, and Folsom Lake—and their significant surface area, inflows and wind fetch that would still contribute to oxygenating these water bodies, the lower carryover storage that would occur under the No Action Alternative is not expected to cause DO depletions or substantial changes in DO that would adversely affect the beneficial uses of these water bodies.

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under Existing Conditions. Moreover, these are large, turbulent rivers with velocities typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under the No Action Alternative would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions.

The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta, relative to Existing Conditions, could affect downstream river temperatures, depending on month and year. Water temperature affects the maximum DO saturation level; as temperature increases, the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5 mg/L at 30°C (86°F) to 11 mg/L at 10°C (50°F) (Tchobanoglous and Schroeder 1987:735). As described in the affected environment section, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under the No Action Alternative would not be expected to cause DO levels to be outside of the range seen historically. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain saturation levels.

Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under the No Action Alternative to substantially alter DO levels relative to Existing Conditions. Any minor reductions in DO levels that may occur under this alternative would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under the No Action Alternative, relative to Existing Conditions.

Delta

Similar to the reservoirs and rivers upstream of the Delta, DO levels in the Delta are primarily affected by water temperature, salinity, Delta channel flow velocities, nutrients (i.e., phosphorus and nitrogen) and aquatic organisms (i.e., photosynthesis, respiration, and decomposition). Sediment oxygen demand of organic material deposited in the low velocity channels also affects Plan Area DO levels.

Under the No Action Alternative, minor DO level changes could occur due to nutrient loading to the Delta relative to Existing Conditions (see WQ-1, WQ-15, WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (Table 8-11). Based on these considerations, excessive nutrients that would cause low DO levels would not be expected to occur under the No Action Alternative.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (see WQ-11). For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under the No Action Alternative would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

As discussed in the section on DO in section 8.3.1.7, *Constitute-Specific Considerations Used in the Assessment, Constitute-Specific Considerations Used in the Assessment* effects of climate change on air and Delta water temperatures are discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In general, waters of the Delta would be expected to warm less than 5 degrees F under the No Action Alternative, relative to Existing Conditions, due to climate change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature under the No Action Alternative due to climate change would generally have relatively minor effects on Delta DO levels.

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act Section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Regional Water Quality Control Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project.

In the Deep Water Ship Channel, low DO events have historically occurred in May–October, and typically in drier years and when flows in the San Joaquin River at Stockton are less than 1,000 cfs (Central Valley Regional Water Quality Control Board 2014, ICF International 2010). Concerns have been raised that flows on the San Joaquin River at Stockton may increase, causing the location of the minimum DO point to shift downstream.

Figure 8-65a shows a box-and-whisker plot of the monthly average flows in the San Joaquin River at Stockton for the months of May–October for Dry and Critical water year types. The figure shows that while flows do change somewhat, they are generally within the range of flows seen under Existing Conditions. Reports indicate that the aeration facility performs adequately under the range of flows from 250–1,000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will likely still be located appropriately to keep DO levels above Basin Plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact on DO in the Deep Water Ship Channel. It is expected that under the No Action Alternative that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act Section 303(d)-listed waterways would not be expected to change relative to Existing Conditions, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur similar to Existing Conditions.

SWP/CVP Export Service Areas

The primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP Export Service Areas would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. For reasons provided above, the Delta waters exported to the SWP/CVP Export Service Areas would not be expected to be substantially lower in DO compared to Existing Conditions. Exported water could potentially be warmer and have higher salinity relative to Existing Conditions, due to climate change. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs. Consequently, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur under the No Action Alternative relative to Existing Conditions.

The effects on DO from implementing the No Action Alternative would not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

There would be no substantial, and likely no measurable, long-term change in DO levels Upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would adversely affect beneficial uses. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be expected to be adversely affected. Various Delta waterways are Clean Water Act Section 303(d)-listed for low DO, but because no substantial decreases in DO levels are expected, greater degradation and impairment of these areas is not expected to occur. This impact is considered to be less than significant.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows relative to Existing Conditions. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to Existing Conditions. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed. Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agricultural use of irrigation water imported from the southern Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% (as a result of climate change and increased water demands) relative to Existing Conditions (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels relative to Existing Conditions. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3%. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that EC levels would be improved under the No Action Alternative relative to Existing

Conditions. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Relative to Existing Conditions, the No Action Alternative would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the Sacramento River at Emmaton (Appendix 8H, *Electrical Conductivity*, Table EC-1). Long-term average levels of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 is generally greater than sea level rise. For electrical conductivity, the Sacramento River at Emmaton is an exception, where sea level rise and increased water demands (see Table 8-62) combine to cause increases in electrical conductivity. The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 14% under the No Action Alternative. Further, the percentage of days out of compliance with the EC objective would increase from 11% under Existing Conditions to 25% under the No Action Alternative. Average EC levels at the western, interior, and southern Delta compliance locations, other than the Sacramento River at Emmaton, would decrease from 1–14% for the entire period modeled and 0–7% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-11). Average EC in the Sacramento River at Emmaton would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during all months, except October and November (Appendix 8H, Table EC-11).

In Suisun Marsh, average EC for the entire period modeled would increase under the No Action Alternative, relative to Existing Conditions, during the months of January through May by 0.1–0.7 mS/cm, depending on the location and month (Appendix 8H, Table EC-21 through Table EC-25). The degree to which the average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the Marsh. Given the Bay-Delta WQCP narrative objective regarding "equivalent or better protection" in lieu of meeting specific numeric objectives, the small increase in EC relative to Existing Conditions would not be expected to adversely affect beneficial uses of Suisun Marsh under the No Action Alternative.

Given that the western Delta is Clean Water Act Section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and average EC levels at western Delta locations under the No Action Alternative, relative to Existing Conditions, has the potential to contribute to additional impairment and adversely affect beneficial uses. While Suisun Marsh also is Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) as to not be measurable and beneficial uses would not be adversely affected.

SWP/CVP Export Service Areas

At the Banks pumping plant, relative to Existing Conditions, the No Action Alternative would result in no additional exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective during the drought period modeled; the frequency of exceedance for both conditions would be 2% (Appendix 8H, Table EC-10). When the entire period modeled is considered, the frequency of exceedances of the EC objective would increase slightly, from 1% under Existing Conditions to 2% under the No Action Alternative (Appendix 8H, Table EC-10). Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, this minimal increase in frequency of exceedance of the EC objective would not adversely affect this beneficial use.

For the entire period modeled, there would be no exceedance of the 1,000 µmhos/cm EC objective at the Jones pumping plant under Existing Conditions and the No Action Alternative (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the agricultural beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the No Action Alternative.

Average EC levels for the entire period modeled would decrease at the Banks pumping plant by 7% and at the Jones pumping plant by 5% under the No Action Alternative, relative to Existing Conditions. As explained above for the Delta, long-term average levels of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 is generally greater than sea level rise. During the drought period modeled, average EC levels would decrease at the Banks pumping plant by 6% and at the Jones pumping plant by 5% under the No Action Alternative, relative to Existing Conditions. Consequently, in the long-term, water delivered to the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regard to EC under the No Action Alternative, relative to Existing Conditions. (Appendix 8H, Table EC-11) Based on the long-term decreases in EC levels that would occur at the Banks and Jones pumping plants, the No Action Alternative would not cause long-term degradation of EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. The No Action Alternative would result in lower average EC levels relative to Existing

Conditions and, thus, would not contribute to additional impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under the No Action Alternative would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act Section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the western Delta under the No Action Alternative has the potential to contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, the No Action Alternative would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones pumping plant. At the Banks pumping plant there would be only a 1% increase in exceedance of the EC objective when the entire period modeled is considered, and no increase in the frequency of exceedance during the drought period. Average EC levels for the entire period modeled would decrease at both plants. Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, the minimal increase in the frequency of exceedance of the EC objective at the Banks pumping plant for the entire period modeled coupled with the long-term average decrease in EC levels at the pumping plants would not adversely affect this beneficial use.

In the Plan Area, the No Action Alternative would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton for the entire period modeled (1976–1991) and during the drought period modeled (1987–1991). Further, long-term average EC levels would increase by 1% for the entire period modeled and 10% during the drought period modeled at Emmaton. The increases in drought period average EC levels that would occur in the Sacramento River at Emmaton would further degrade existing EC levels and thus contribute additionally to adverse effects on the agricultural beneficial use. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act Section 303(d) listed for elevated EC and the increases in long-term average EC and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton could make beneficial use impairment measurably worse. This impact is considered to be significant.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Appendix 8I, *Mercury*, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under the No Action Alternative relative to Existing Conditions are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions due to changes in flows under the No Action Alternative.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs (Central Valley Regional Water Quality Control Board 2011c, State Water Resources Control Board 2003) as well as the State Water Board's Statewide Mercury Control Program. The TMDL for the American River was in process for CEQA scoping (Central Valley Regional Water Quality Control Board 2011d), but now will be incorporated into a statewide mercury TMDL under development by the State Water Board. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

As shown in Figures 8-53a, 8-53b,8-54a, and 8-54b, comparisons in percentage change of assimilative capacity of waterborne mercury concentrations relative to the 25 ng/L ecological risk benchmark under the No Action Alternative compared to the Existing Condition would vary only slightly among stations. Peak losses of assimilative capacity for mercury would be less than 0.1% for all sites comparing Existing Conditions to the No Action Alternative. These changes are not expected to result in adverse effects to beneficial uses. Peak annual average methylmercury concentrations for drought conditions occurred at the San Joaquin River at Buckley Cove: 0.161 ng/L for Existing Conditions and 0.167 ng/L for the No Action Alternative (Appendix 8I, *Mercury*, Table I-6). These differences are less than 5%. Methylmercury concentrations exceed criteria at all locations and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are shown in Appendix 8I, Figures I-2 and I-3. Note that concentrations under Existing Conditions and the No Action Alternative are all very similar to each other (Appendix 8I, Figures I-2 and I-3, Tables I-5 and I-6).

Similarly, estimates of fish tissue mercury concentrations and exceedance quotients show almost no differences would occur among sites for the No Action Alternative as compared to Existing Conditions for the Delta sites (Figures 8-55a and 8-55b; Appendix 8I, *Mercury*, Tables I-7a, b). Peak exceedance quotients for drought conditions are all at the San Joaquin River at Buckley Cove (4.3 for Existing Conditions; 4.5 for the No Action Alternative; Eq2 model, Table I-7b). These small differences of less than 10% are not expected to further degrade water quality, with regards to mercury, by measurable levels, and thus beneficial use impairment would not be made discernibly worse. Similar to waterborne concentrations of methylmercury, the fish tissue concentrations and exceedance quotients would be highest at the San Joaquin River, Buckley Cove site during drought years (Appendix 8I, Tables I-7a, b). All modeled fish tissue mercury concentrations exceed tissue guidelines, with exceedance quotients greater than 1 (Appendix 8I, Tables I-7a, b).

SWP/CVP Export Service Areas

The Banks and Jones pumping plants are expected to show only very small losses of assimilative capacity or changes in fish tissue concentration of mercury for the No Action Alternative in relation to Existing Conditions [less than 1% for assimilative capacity decreases; greatest decrease was at Jones Pumping Plant of 0.6% relative to Existing Conditions] (Figures 8-53a through 8-54b; Appendix 8I, *Mercury*, Tables I-7a, b). Any increases in mercury concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to mercury.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta for Existing Conditions and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to each other among alternatives. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for the No Action Alternative as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show only very small losses of assimilative capacity or changes in fish tissue concentration of mercury for the No Action Alternative as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, the No Action Alternative would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed, nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many dischargers have already improved facilities to remove more nitrate, many others are likely to do so over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport (Appendix 8J, *Nitrate*, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49, Appendix 8J, *Nitrate*, Figure 2). Under the No Action Alternative, long-term average flows at Vernalis would decrease an estimated 6% relative to Existing Conditions (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 4 and 5). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under the no Action Alternative, relative to Existing Conditions. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <3%) for all locations and months (Appendix 8J, Table 6).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Regional Water Quality Control Board 2010a:32).
- Under the No Action Alternative, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under the No Action Alternative, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification upgrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and the No Action Alternative, the increase is expected to be greater under Existing Conditions than for the No Action Alternative due to the upgrades that are assumed under the No Action Alternative.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly (Appendix 8J, *Nitrate*, Table 4 and 5). No additional exceedances of the MCL are anticipated (Appendix 8J, Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions relative to the MCL was negligible (i.e., <3%) for both Banks and Jones pumping plants (Appendix 8J, Table 6). As discussed above in the Delta region, nitrate-N concentrations would be higher than indicated in the mixing modeling results for areas receiving Sacramento River water, including Banks and Jones pumping plants, downstream of the SRWTP discharge at Freeport in the Existing Conditions (by < 1 mg/L-N), due to conversion of ammonia to nitrate within the Delta. For the No Action Alternative, nitrate levels would also be slightly higher than the mixing modeling results suggests because full nitrification/partial denitrification of the SRWTP discharge was not accounted for. Nonetheless, the total nitrogen load from the SRWTP is expected to decrease substantially due the facility's upgrades. Hence, long-term average nitrate-N concentrations would be expected to decrease under the No Action Alternative, relative to Existing Conditions.

Any short-term, negligible increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to nitrate.

In summary, based on the discussion above, effects on nitrate of facilities operation and maintenance are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this

constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <3%) for all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <3%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment from nitrate. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to Existing Conditions. While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta. Consequently, long-term average DOC concentrations under the No Action Alternative would not be expected to change by frequency, magnitude and geographic extent, relative to Existing Conditions and, and thus, would not adversely affect the MUN beneficial use, or any other beneficial uses, in water bodies of the affected environment located upstream of the Delta.

Delta

Relative to Existing Conditions, the No Action Alternative would result in mostly minor changes (i.e., up to 4% increases and 6% decreases) in long-term average DOC concentrations at all Delta assessment locations. Increases in long-term average DOC concentrations for the 16-year (1976–1991) hydrologic period modeled would not be greater than 0.1 mg/L, with the largest predicted change occurring at Rock Slough during the 1987–1991 drought period modeled, where average DOC concentration would be predicted to increase by approximately 4% (Appendix 8K, *Organic Carbon*, DOC Table 1). At all 11 assessment locations, modeled long-term average DOC concentrations under the No Action Alternative would exceed 2 mg/L 94–100% of the time. The frequency with which average DOC concentration exceeds the 3 mg/L threshold would change only slightly, with exception to predicted changes at both the Banks and Jones pumping plants.

At the Banks pumping plant, the frequency with which average DOC concentration would exceed 3 mg/L would increase from 64% under Existing Conditions to 71% under the No Action Alternative (an increase from 57% to 75% during the drought year period of 1987–1991) (Appendix 8K, *Organic Carbon*, DOC Table 1). At the Jones pumping plant, the frequency that long-term average DOC concentration would exceed 3 mg/L would increase from 71% under Existing Conditions to 80% under the No Action Alternative (an increase from 72% to 90% for the drought period modeled). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at the Banks and Jones pumping plants would be small. At the Banks pumping plant, the frequency long-term average DOC concentrations would exceed 4 mg/L would increase from 33% under Existing Conditions to 35% under the No Action Alternative (an increase from 42% to 43% for the drought period), while at the Jones pumping plant the modeled exceedance frequency would rise from 26% to 28% (with no predicted change in frequency of exceedance for the drought period). Trends in concentration threshold exceedances at the other assessment locations would follow that described for the Banks and Jones pumping plants, but the overall magnitude of threshold exceedance change would be less. While the No Action Alternative would generally lead to slightly higher long-term average DOC concentration in the western and southern Delta, the predicted change would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration (i.e., ≤0.1 mg/L).

SWP/CVP Export Service Areas

With respect to the potential for effects resulting from No Action Alternative induced changes on long-term average DOC concentrations in the water exported via the Banks and Jones pumping plants, long-term average DOC concentrations would increase only slightly. Under the No Action Alternative, long-term average DOC concentrations at the Banks and Jones pumping plants would increase by as much as 3% relative to Existing Conditions (Appendix 8K, *Organic Carbon*, DOC Table

1). A greater frequency of exports greater than 3 and 4 mg/L would be predicted to occur at both Banks and Jones pumping plants, as previously discussed for the Delta, although the increased frequency of 4 mg/L would be comparatively small (see Delta discussion above). As previously stated, the predicted change in long-term average DOC concentrations relative to existing conditions would not be expected to be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial use, within the SWP and CVP Service Area.

Maintenance of SWP and CVP facilities under the No Action Alternative would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected environment. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that the MUN beneficial use, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the No Action Alternative would result in mostly minor changes (i.e., up to 4% increases and 6% decreases) in long-term average DOC concentrations at all Delta assessment locations, with the largest increase (i.e., 4%) occurring at Rock Slough during the modeled drought period. While the No Action Alternative would generally lead to slightly higher long-term average DOC concentration (i.e., ≤0.1 mg/L) in the western and southern Delta, the predicted change would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of No Action Alternative effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to existing condition, long-term average DOC concentrations would increase only slightly at Banks and Jones pumping plants. The predicted change in long-term average DOC concentrations relative to Existing Conditions would not be expected to be of sufficient magnitude to adversely affect MUN beneficial uses, or any other beneficial use, within the SWP and CVP Service Area.

Based on the above, the No Action Alternative would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.1 mg/L at any single Delta assessment location (i.e., ≤4% relative increase). The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP and CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations would not be expected to increase substantially, no long-term water quality degradation with respect to DOC would be expected to occur and, thus, no significant impacts on beneficial uses would occur. This impact would be less than significant.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to Existing Conditions would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement BMPs for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, the No Action Alternative would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total Coliform

- In the Sacramento Valley, the highest total coliform concentrations (>10,000 MPN/100 ml) were located near urban areas.
- Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.
- The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the “appearance” of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

- Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.
- The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.
- *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.
- Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal Coliform

- There was limited data from which to make comparisons/observations.

Cryptosporidium and Giardia

- Data were available only for the Sacramento River, limiting the ability to make comparisons between sources.
- Often not detected and when detected, concentrations typically less than 1 organism per liter.
- There may be natural/artificial barriers/processes that limit *Cryptosporidium* transport to water. Significant die off of those that reach the water may contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the No Action Alternative relative to Existing Conditions would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

SWP/CVP Export Service Areas

The No Action Alternative is not expected to result in substantial changes in pathogen levels in Delta waters, relative to Existing Conditions. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Areas waters under the No Action Alternative relative to Existing Conditions.

The effects on pathogens from implementing the No Action Alternative is determined to not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

There is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the No Action Alternative is not expected to result in substantial changes in pathogen levels in Delta waters relative to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

Residues of "legacy" organochlorine (OC) pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Regional Water Quality Control Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural storm-water runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Regional Water Quality Control Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Green and Young 2006), although diuron can be found much less frequently in surface waters throughout the year (Johnson et al. 2010).

Monitoring for pyrethroid insecticides in mainstem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the No Action Alternative, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the No Action Alternative, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito, and the San Joaquin River at Vernalis would change relative to Existing Conditions.

Averaged over the entire period of record, seasonal mean flow rates would largely remain unchanged on the Sacramento River and Feather Rivers (Appendix 8L, *Pesticides*, Tables 1–4). Summer average flow rates on the American River would decrease by 16% relative to Existing Conditions. During the winter months, however, average flow rates would increase by as much as 9% on the American River. Similarly, summer average flow rates on the San Joaquin River would decrease by 12% relative to Existing Conditions, while winter average flow rates would increase slightly.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 12%, relative to Existing Conditions, are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Studies documenting pesticide associated toxicity in the Delta demonstrate the dynamic nature of pesticide input. Pesticide loads entering the Delta, but originating outside of the Delta, do so typically in pulses and particularly after significant precipitation induced surface runoff events (Kuivila and Foe 1995). Through the greater hydraulic capacity of the Delta, and through tidal mixing, these pulses become diluted and spread about the Delta. Although it is difficult to definitively conclude that either the Sacramento River or San Joaquin River is a consistently dominant source of pesticide, a compilation of Delta diazinon and chlorpyrifos data suggest that these two OP insecticides have both been more frequently observed in the San Joaquin River, and at concentrations more frequently exceeding OP specific aquatic life criteria (Central Valley Regional Water Quality Control Board 2006).

No similar observation as to incidence frequency can be made regarding pyrethroid insecticides, primarily owing to a dearth of monitoring data. Pyrethroid insecticides have been observed in Delta waterways, but there is little evidence supporting any particular geographic or seasonal trend (Werner et al. 2010). Unlike that for chlorpyrifos and diazinon, data for pyrethroids are insufficient to determine the relative loading from particular source waters.

Diuron has been detected in the Delta throughout the year, but with greater magnitude and frequency during the winter storm season. Unlike that for chlorpyrifos and diazinon, data for diuron are insufficient to determine the relative loading from particular source waters.

Granting the assessment challenges imposed by data limitations, there does appear sufficient information to suggest that the San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks. Although data is insufficient to make similar observations pertaining to diuron, trends in pyrethroid use suggest that pyrethroid insecticides may in the near future reflect the historic trends of OP insecticides, namely that of relative frequency, magnitude, seasonality and geographic distribution. Based on these general observations, this assessment utilizes source water fingerprinting to make qualitative judgments as to increased risk of pesticide related aquatic life toxicity and judgments as to the possibility of associated long-term degradation to water quality.

Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. For the No Action Alternative, San Joaquin River fractions would not increase more than 10% at any of the 11 modeled assessment locations, with exception to Jones pumping plant during the modeled drought period, where San Joaquin River fraction would increase 12–14% in October and November relative to Existing Conditions, yet would continue to represent less than 43% of the total source water volume (Appendix 8D, *Source Water Fingerprinting Results*). Similarly, Sacramento River fractions would not increase more than 10% at any of the 11 modeled assessment locations. However, these large fractional increases in Sacramento River occur through near equal replacement of San Joaquin River water and, as such, would likely represent an overall decrease in risk of pesticide-related toxicity to aquatic life. There would be no modeled increases in Delta agricultural fractions greater than 2%.

These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

SWP/CVP Export Service Areas

Assessment of effects in SWP and CVP Export Service Areas is based on effects seen in the Delta at the Banks and Jones pumping plants. Under the No Action Alternative, Sacramento, San Joaquin and in-Delta Agricultural source water fractions at Banks would not increase more than 5% in any month relative to Existing Conditions (Appendix 8D, *Source Water Fingerprinting Results*). At Jones during the modeled drought period, San Joaquin River source water fractions would increase by as much as 12–14% in October and November relative to Existing Conditions, yet would continue to represent less than 43% of the total source water volume. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP service area.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under the No Action Alternative, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of the No Action Alternative effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, the No Action Alternative would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP and CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may affect phosphorus levels are discussed below.

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: "previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables (Tetra Tech 2006b, *Conceptual Model for Organic Carbon in the Central Valley*). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006b:4-1 to 4-2). Attempts discussed under Impact WQ-15 also showed weak correlation between nitrate and flows for major source waters to the Delta. The linear regressions between average dissolved ortho-phosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis (Figures 8-57 and 8-58, respectively). As expected, neither relationship is very strong, although over the large range in flows for the Sacramento River, the relationship is stronger than for the San Joaquin River. However, over smaller changes in flows, neither relationship can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., <10,000 cfs) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated for the No Action Alternative, relative to Existing Conditions. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations shown in Figure 8-56, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

The assessment of effects of phosphorus under the No Action Alternative in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations shown in Figure 8-56, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

In summary, based on the discussion above, effects on phosphorus of facilities operations and maintenance are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for the No Action Alternative, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under the No Action Alternative, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under the No Action Alternative in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river or its tributaries. Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative. This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010a) and State Water Board (2010d, 2010e) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, as previously discussed in 8.1.3.15.

Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cfs, as shown in Appendix 8M, *Selenium*, Table M-33 and Figures M-7 through M-20. Modeling of flows for the San Joaquin River at Vernalis indicates that average annual flows under the No Action Alternative would vary by less than 10% from Existing Conditions (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative.

Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so under the No Action Alternative. The negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Existing Conditions and the No Action Alternative are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-10 through M-29 for most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-59b present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Relative to Existing Conditions, the No Action Alternative would result in little to no change in average selenium concentrations in water at all modeled Delta assessment locations. Long-term average concentrations at most locations would be the same or lower, with the exception of Old River at Rock Slough and North Bay Aqueduct during the drought period modeled (1987–1991) and Jones pumping plant for the entire period modeled (1976–1991) and drought periods modeled (Appendix 8M, Table M-9a). Long-term average concentrations would increase negligibly (0.01–0.02 μg/L) at these locations, resulting in a reduction of assimilative capacity of <1%, relative to the 1.3 μg/L USEPA draft water quality criterion (Figure 8-59a). The long-term average selenium concentrations in water under the No Action Alternative would range from 0.09–0.38 μg/L (Appendix 8M, Table 9a), well below the USEPA draft water quality criterion of 1.3 μg/L.

Relative to Existing Conditions, the No Action Alternative would result in little to no change in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), with the largest increase being 0.01 mg/kg dry weight at Buckley Cove for the drought period (Appendix 8M, Table M-20). During the drought period, concentrations of selenium in sturgeon in the western Delta would increase slightly, with about a 0.09 mg/kg dry weight (1%) increase for the San Joaquin River at Antioch (Appendix 8M, Tables M-30 and M-31).

Modeled selenium concentrations in fish and bird eggs were compared with effect benchmarks to evaluate the potential for selenium to exceed levels of concern for toxicity or health advisories. These effects benchmarks included Levels of Concern for whole fish and bird eggs, Toxicity Thresholds for whole fish, bird eggs, and sturgeon, and Advisory Tissue Levels for fish fillets consumed by people. Toxicity Threshold Exceedance Quotients (i.e., modeled tissue concentration divided by Toxicity Threshold benchmarks) were determined for selenium concentrations in all biota for the entire period modeled and for the drought period modeled. Likewise, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) were also calculated for selenium concentrations in all biota. All Exceedance Quotients for whole fish, bird eggs, and fish fillets are less than 1.0, indicating low probability of adverse effects (Appendix 8M, Table M-20). Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon from the western Delta exceed 1.0 for the modeled drought period, indicating a higher probability for adverse effects for drought years (Appendix 8M, Table M-32). Relative to Existing Conditions, there would be no increase in any exceedance quotient at any Delta assessment location, except for the whole body fish Toxicity Threshold Exceedance Quotient for the San Joaquin River at Buckley

Cove for the drought period (from 0.29 to 0.30). Figures 8-61a through 8-64b show the exceedance quotients based on the lowest benchmarks for whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), fish fillets, and sturgeon in drought years at each modeled location. In summary, relative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations throughout the Delta. The No Action Alternative would not be expected to substantially increase the frequency with which applicable toxicity and level of concern benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Relative to Existing Conditions, the No Action Alternative would result in little to no change in long-term average selenium concentrations in water at the south Delta pumping plants. At the Banks pumping plant, there would be no change in long-term average concentrations for the entire period modeled or the drought period modeled (Appendix 8M, Table M-9a). At the Jones pumping plant, selenium concentrations would increase by 0.01 μg/L for the entire period modeled and by 0.02 μg/L for the drought period modeled (Appendix 8M, Table M-9a), which would correspond to a reduction in assimilative capacity of about 1% (Figure 8-59a). Furthermore, the modeled selenium concentrations in water (Table M-9a) for the No Action Alternative would range from 0.21–0.29 μg/L, well below the USEPA draft water quality criterion of 1.3 μg/L.

Relative to Existing Conditions, the No Action Alternative would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Table M-20). Concentrations of selenium in biota would not be expected to exceed any benchmarks for biota (Figures 8-61a through 8-64b; Appendix 8M, Table M-10).

Relative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations at the SWP/CVP Export Service Areas, because there would essentially be no change in selenium concentrations at the Banks and Jones pumping plants. Thus, the No Action Alternative would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Export Service Areas or substantially degrade the quality of water in the Export Service Areas, with regard to selenium.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d and State Water Board 2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that the No Action Alternative would result in essentially no change in selenium concentrations throughout the Delta, with all changes on the order of 0.02 μg/L or less (i.e., <1%). Furthermore, there would not be an increased risk of exceeding toxicity and level of concern benchmarks for biota.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, the No Action Alternative would result in essentially no change in long-term average selenium concentrations at the Banks pumping plant, and very little increase (0.01 μg/L) at the Jones pumping plant.

Based on the above, selenium concentrations that would occur in water under this alternative would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial uses to be made discernibly worse. This impact is considered to be less than significant.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Relative to Existing Conditions, under the No Action Alternative sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, *Trace Metals*, Figure 1). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 3). While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the No Action Alternative would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N, *Trace Metals*, Tables 1–7). For example, average dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 1.7 μg/L, 2.4 μg/L, and 1.7 μg/L, respectively. The 95th percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 3.4 μg/L, 4.5 μg/L, and 2.4 μg/L, respectively. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment (Tables 8-58 and 8-59). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur under the operational scenario for this alternative.

Based on comments received during public review of the Draft EIR/EIS, further evaluation of aluminum data and potential effects are included herein. Aluminum has potential to result in aquatic toxicity effects as well as human health and nuisance aesthetic concerns in potable water. Regarding potential aquatic life effects, monthly DWR data collected in 2013–2014 indicate that the maximum and 95th percentile dissolved aluminum in the Sacramento River exceed the USEPA's default chronic criterion of 87 μg/L, whereas the San Joaquin River concentrations are well below the criterion, and no data were identified for the Bay source water. However, the USEPA national recommended criteria developed in 1988 is recognized as a highly conservative value based on limited toxicity test data and very low water hardness levels. A recent study in Arizona evaluated aluminum criteria with the USEPA recalculation procedure using an updated and comprehensive toxicity test database that determined a hardness-based relationship for aluminum (Pima County Wastewater Management Department 2006). The Pima County study hardness-dependent equation for dissolved aluminum indicates that a chronic criteria of 287 μg/L (at 25 mg/L hardness as $CaCO_3$) better represents potential aluminum toxicity in ambient water. Similar to the analysis for the other trace metals above, based on the relatively similar Sacramento and San Joaquin River aluminum concentrations, and maximum concentrations not having potential to cause chronic (or acute) toxicity, no change in mixing of the source waters would result in more frequent or potential for toxicity or degradation in the Delta.

For metals of primarily human health and drinking water concern (aluminum, arsenic, iron, manganese), average and 95th percentile concentrations are also very similar (Appendix 8N, Tables 8–10). The arsenic criterion and aluminum primary MCL were established to protect human health from the effects of long-term chronic exposure, while secondary maximum contaminant levels for aluminum, iron, and manganese were established as reasonable goals for drinking water quality. The primary source water average concentrations for aluminum, arsenic, iron, and manganese are below these criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for aluminum, arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur under this alternative.

Relative to Existing Conditions, facilities operation under the No Action Alternative would result in negligible change in trace metal concentrations throughout the Delta. The No Action Alternative would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

SWP/CVP Export Service Areas

The No Action Alternative is not expected to result in substantial changes in trace metal concentrations in Delta waters. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters, exported from the Delta through the south Delta pumps, under the No Action Alternative.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the No Action Alternative.

The assessment of the No Action Alternative effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the No Action Alternative is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, negligible change in long-term trace metal concentrations throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows relative to Existing Conditions. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during “first flush events” and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the No Action Alternative are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, relative to Existing Conditions.

Changes in land use that would occur relative to Existing Conditions could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under the No Action Alternative there would be no project actions implemented within or affecting the Delta region of the affected environment. Any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to Existing Conditions. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions. As such, any minor TSS and turbidity changes that may occur under the No Action Alternative would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The No Action Alternative is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions. As such, the No Action Alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters relative to Existing Conditions.

The effects on TSS and turbidity from implementing the No Action Alternative is determined to not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Changes river flow rate and reservoir storage that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, any land use changes that may occur would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the river contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the No Action Alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels in Delta waters, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different from Existing Conditions, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities

Under the No Action Alternative, existing facilities and operations would be continued and none of the Conservation Measures 1–21 associated with the BDCP alternatives would be implemented. However, construction activities would occur in the affected environment over time that are not directly associated with the BDCP alternatives (herein termed “non-BDCP” effects). Routine non-BDCP construction activities that may occur for urbanization and infrastructure to accommodate population growth would generally be anticipated to involve relatively dispersed, temporary, and intermittent land disturbances across the affected environment. Major, or more complex, non-BDCP infrastructure construction projects that are identified under the No Action Alternative which may involve substantial construction activities and potential construction-related water quality effects are identified in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and include:

- Levee rehabilitation projects in the Delta by DWR and local reclamation districts.
- Suisun Channel (Slough) Operations and Maintenance (shipping channel dredging)
- Sacramento Deep Water Ship Channel Project (shipping channel dredging).
- San Joaquin River Restoration Program.
- Dutch Slough Tidal Marsh Restoration Project.
- Suisun Marsh restoration activities (tidal marsh restoration)
- Yolo Bypass Salmonid Habitat Restoration and Fish Passage.

Potential construction-related water quality effects associated with non-BDCP activities may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury). However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

It is assumed that non-BDCP construction activities would be regulated, as necessary, under state grading and erosion control regulations, proponent-defined CEQA-NEPA mitigation measures and BMPs, and applicable environmental permits such as the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002, as amended by Order No. 2010-0014-DWQ), project-specific WDRs or CWA Section 401 water quality certification from the appropriate Regional Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. Consequently, relative to the Existing Conditions, the potential contaminant discharges associated with construction-related activities that may occur under the No Action Alternative would be avoided and minimized upon implementation of BMPs and adherence to permit terms and conditions. Consequently, construction-related activities would not be expected to cause constituent discharges of sufficient magnitude to result in a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area.

***CEQA Conclusion*:** BDCP construction-related contaminant discharges under the No Action Alternative would not occur. Other reasonably foreseeable projects that are independent from BDCP would result in construction related impacts that are temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would therefore not contribute to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Relative to Existing Conditions, the construction-related effects of other projects in the Delta would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality on a long-term average basis with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under the No Action Alternative. Consequently, any modified reservoir operations under the No Action Alternative are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions.

Delta

Modeled residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through October under the No Action Alternative are greater than under than Existing Conditions by 0–7 days (Table 8-60a), a small increase, given that modeled residence times of the six Delta sub-regions range from 5–49 days under Existing Conditions. One exception is the East Delta, where modeled residence times are expected to increase by up to 20 days relative to Existing Conditions. The changes in residences time are driven by a number of factors accounted for in the modeling, including climate change, sea level rise, and changes in operations and maintenance that affect net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Thus, the summer and fall period average residence times provide a general direction and degree to which water residence times may change. Because the change is relatively small, it is unknown whether the increase in modeled residence times expected under the No Action Alternative relative to Existing Conditions will result in measurable increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs is discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley discussed in Appendix 5A, Section D indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9–4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under the No Action Alternative, relative to Existing Conditions.

CVP/SWP Export Service Area

The assessment of effects on *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under the No Action Alternative, exports from Banks and Jones pumping plants will consist of water characteristic of Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the *Delta* section above. Therefore, an increase in *Microcystis* blooms, and thus microcystins concentrations, is expected in the mixture of source waters exported from Banks and Jones pumping plants under the No Action Alternative relative to Existing Conditions.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under the No Action Alternative may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under the No Action Alternative, relative to Existing Conditions.

CEQA Conclusion: Based on the above, the No Action Alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to increased water temperatures from climate change under the No Action Alternative, long-term water quality degradation may occur in the Delta and water exported from the Delta to the SWP and CVP Export Service Areas. Thus, impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. This impact is considered to be significant and unavoidable.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-32) concluded that the No Action Alternative would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Bromide
- Dissolved Oxygen
- Dissolved Organic Carbon (DOC)
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. Elevated concentrations of bromide and DOC also are of concern in drinking water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. The strong tidal nature of this area and proximity to the ocean make salinities too high to be suitable for these uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, bromide, DO, DOC, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of the No Action Alternative on chloride and EC in the Delta were determined to be significant/adverse. Increases in chloride concentrations are of concern for their potential to impact municipal drinking water aesthetics; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in chloride in Delta outflow would not adversely affect any beneficial uses of San Francisco Bay. Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. However, potential effects on bay salinity are discussed further below, with consideration to effects on fish and wildlife beneficial uses.

While effects of the No Action Alternative on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Because the potential change in *Microcystis* levels were found to be significant in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San Francisco Bay are discussed. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under the No Action Alternative would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Relative to Existing Conditions, total nitrogen loads to Suisun and San Pablo Bays would decrease by 32% (Appendix 8O, *San Francisco Bay Analysis*, Table

O-1). The change in nitrogen loading to Suisun and San Pablo Bays under the No Action Alternative would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for the No Action Alternative is estimated to increase by 5% relative to Existing Conditions (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected decrease in total nitrogen loading and increase in phosphorus loading that would occur in Delta outflow to San Francisco Bay are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to nutrients.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, *San Francisco Bay Analysis*, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under the No Action Alternative. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 3 kg/year (1%). Methylmercury load, relative to Existing Conditions, is estimated to increase by 0.09 kg/year (3%). The estimated total mercury load to the Bay is 263 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San Francisco Bay due to the No Action Alternative are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Salinity

Salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the alternative could affect salinity in San Francisco Bay. According to the Delta Atlas (California Department of Water Resources 1995), average historical tidal flow through the Golden Gate Bridge is 2,300,000 cfs and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow due to the No Action Alternative (shown in Appendix 5A, Section C.7). Thus, the changes in Delta outflow due to the No Action Alternative would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Selenium

Changes in source water fraction and net Delta outflow under the No Action Alternative, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 3% (Appendix 8O, *San Francisco Bay Analysis*, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under the No Action Alternative, the long-term average total selenium concentration of the North Bay is estimated to be 0.13 µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to the No Action Alternative are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

Microcystis

Microcystis has not been detected in embayments of the San Francisco Bay downstream of Suisun Bay. Low levels of microcystins occur throughout San Francisco Bay, but their concentrations do not correspond to *Microcystis* abundance, nor is there evidence that they have been transported downstream from *Microcystis* blooms that have occurred in the Delta (Senn and Novick 2013). The low levels of microcystins present in San Francisco Bay are likely derived from cyanobacteria besides *Microcystis*, such as *Cyanobium* sp. and *Synechocystis*, which are currently resident in the San Francisco Bay at levels well below bloom magnitude (Senn and Novick 2013). Elevated microcystin levels could occur at various locations in the Delta during *Microcystis* blooms under the No Action Alternative, but because of the sufficient dilution available in San Francisco Bay, downstream transport of Delta-derived microcystins are not expected to result in measurable changes in the microcystin levels of San Francisco Bay.

The absence of *Microcystis* in San Francisco Bay is likely directly related to its intolerance of elevated salinity, as its growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities of this magnitude for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow. However, high Delta outflows occur during wet years and during the winter and spring runoff season, under which water temperatures are expected to be low, turbidity high, and water residence times low, making the environment of San Pablo Bay unsuitable for *Microcystis* growth. Additionally, these hydrodynamics conditions typically only occur when the potential for *Microcystis* blooms to occur upstream of, and thus potentially seed *Microcystis* to, San Pablo Bay are minimal. The No Action Alternative is not expected to result in significant modification to net Delta outflows or the timing of high outflow events related to wet season runoff. Thus, the effects of the No Action Alternative on *Microcystis* levels in San Francisco Bay are expected to be negligible.

CEQA Conclusion: Based on the above, the No Action Alternative would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions; therefore, no substantial changes these constituents' levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 32% reduction in total nitrogen load and 5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (3 kg/year; 1%) and methylmercury load (0.09 kg/year; 3%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 3%, but estimated total and dissolved selenium concentrations under the No Action Alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). Intakes 1 through 5 would introduce large, multi-story industrial concrete and steel structures approximately 55 feet in height from river bottom to the top of the structure with a length of 900–1,600 feet depending on the location. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Construction of a 750-acre Intermediate Forebay near Hood is also included in this alternative.

Construction of all structural components under Alternative 1A could potentially occur over a period of 9 or more years, although construction of individual components would occur on shorter time scales (See Appendix 3C, *Construction Assumptions for Water Conveyance Facilities*). Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include Fall X2. CM1–CM3 would manage the routing, timing, and amount of flow through the Delta. CM4–CM11 would restore, enhance, and manage physical habitats on a natural community scale. CM11–CM21 are designed to reduce other stressors on a species scale. See Chapter 3, *Description of Alternatives*, Section 3.5.2, for additional details on Alternative 1A.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 1A, over the long term, average annual delta exports are anticipated to increase by 312 TAF relative to Existing Conditions, and by 1016 TAF relative to the No Action Alternative. Since, over the long-term, approximately 50% of the exported water will be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 1–Old River at Rock Slough for ALL years (1976–1991), which shows increased SJR percentage and decreased SAC percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 1A, long-term average annual Delta outflow is anticipated to decrease 323 TAF relative to Existing Conditions due to both changes in operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is increased sea water intrusion in the west Delta. The increase of sea water intrusion in the west Delta under Alternative 1A is greater relative to the No Action alternative because the No Action alternative includes operations to meet Fall X2, whereas Existing Conditions and Alternative 1A do not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 1A by 1072 TAF relative to the No Action Alternative, due only to changes in operations. The increases in sea water intrusion (represented by an increase in BAY percentage) can be seen, for example, in Appendix 8D, ALT 1A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment in the Upstream of the Delta Region would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 1A than under Existing Conditions, and would be the same as would occur under the No Action Alternative. Thus, for the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 1A as would occur under the No Action Alternative, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 1A, relative to the No Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This change would be attributable only to operations of Alternative 1A, since the same assumptions regarding water demands, climate change, and sea level rise are included in both Alternative 1A and the No Action Alternative.

Table 8-64. Estimated Ammonia-N (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 1A

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 1A	0.068	0.089	0.068	0.060	0.057	0.060	0.058	0.062	0.063	0.065	0.073	0.077	0.067

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 1A and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Regional Water Quality Control Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia concentration (1.5 mg/L-N in Apr-Oct, 2.4 mg/L-N in Nov-Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-64 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-64 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 1A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September and in November, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 1A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 1A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 1A, relative to the No Action Alternative, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D, *Source Water Fingerprinting Results*). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 1A, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

NEPA Effects: As discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 1A, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia. In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 1A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under the Alternative 1A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 1A relative to Existing Conditions. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impacts on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Additionally, implementation of CM12–CM21 would not be expected to substantially alter ammonia concentrations in the affected environment. The effects of ammonia from implementation of CM2–CM21 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds. Boron loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. Under Alternative 1A, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in association with changed operations, climate change, and increased water demands), and would remain virtually the same relative to the No Action Alternative considering only changes associated with Alternative 1A operations (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). The reduced flow would result in possible increases in long-term average boron concentrations of about 2%, relative to the Existing Conditions, with no change relative to the No Action Alternative (Appendix 8F, Table Bo-32). However, the small increases in lower San Joaquin River boron levels that may occur under Alternative 1A, relative to Existing Conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Moreover, any negligible change in boron concentration would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 1A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to the Existing Conditions and the No Action Alternative, Alternative 1A would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations (i.e., 14% reduction at North Bay Aqueduct at Barker Slough and 6% reduction at the San Joaquin River at Buckley Cove, compared to Existing Conditions) (Appendix 8F, *Boron*, Table Bo-6). Moreover, the direction and magnitude of predicted changes for Alternative 1A are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. The comparison to Existing Conditions reflects changes due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

The long-term average boron concentrations for the 16-year period modeled would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 13% at Franks Tract, 10% at Old River at Rock Slough, and 9% at the Sacramento River at Emmaton) (Appendix 8F, *Boron*, Table Bo-6). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased boron concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of the assessment methods for changes in source water concentrations caused by project-related hydrodynamic changes is included in Section 8.3.1.3, *Plan Area*. While uncertain, the magnitude of boron increases may be greater than indicated herein and would affect the western Delta assessment locations the most (since they are influenced to the greatest extent by the Bay source water), and thus would not be anticipated to substantially affect agricultural use of water because diversions occur primarily at interior Delta locations.

The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative conditions (Appendix 8F, *Boron*, Table Bo-3A). Increased boron concentrations would result in minor reductions in the modeled long-term average assimilative capacity with respect to the 2,000 µg/L human health advisory objective. The reductions in long-term average assimilative capacity of up to 6% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) also would be small with respect to the 500 µg/L agricultural objective (Appendix 8F, Table Bo-7). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 1A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Under Alternative 1A, improvement in long-term average boron concentrations would occur at the Banks and Jones pumping plants as a result of export of a greater proportion of low-boron Sacramento River water. Long-term average boron concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 22% at Banks and by as much as 18% at Jones relative to Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table

Bo-6). Commensurate with the decrease in boron concentrations in exported water to the San Joaquin River basin, there could be reduced boron loading and concentrations in the lower San Joaquin River related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in boron is difficult to predict, the relative decrease in overall loading of boron to the export service area would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 1A would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 1A would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations (i.e., up to 13% increase) in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 1A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 1A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 1A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** The implementation of the other conservation measures (i.e., CM2–CM21), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4–CM10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to Existing Conditions. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12–CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12–CM21 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of CM2–CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 1A would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 1A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 1A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 1A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that may occur under Alternative 1A, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 1A would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with the exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River (Appendix 8E, *Bromide*, Table 4). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 71 μg/L (38% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 104 μg/L (94% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L bromide threshold exceedance frequency would increase from 49% under Existing Conditions to 51% under Alternative 1A (55% to 75% during the modeled drought period) and the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 22% under Alternative 1A (0% to 48% during the modeled drought period). In contrast, increases in bromide at Staten Island would result in a 50 μg/L bromide threshold exceedance increase from 47% under Existing Conditions to 73% under Alternative 1A (52% to 75% during the modeled drought period). However, unlike Barker Slough, modeling shows that the long-term average bromide concentrations at Staten Island would exceed the 100 μg/L assessment threshold concentration 1% under Existing Conditions and 3% under Alternative 1A (0% to 2% during the modeled drought period) (Appendix

8E, *Bromide*, Table 4). The long-term average bromide concentrations would be about 61 μg/L (62 μg/L during the modeled drought period) at Staten Island under Alternative 1A. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. The comparison to Existing Conditions reflects changes in bromide due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

In comparison, Alternative 1A relative to the No Action Alternative would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants (Appendix 8E, *Bromide*, Table 4). Increases would be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 43% (93% for the modeled drought period). Increases in long-term average bromide concentrations would be less than 27% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action Alternative, changes in the frequency with which concentration thresholds of 50 μg/L and 100 μg/L are exceeded are of similar magnitude to those previously described for Existing Conditions comparison (Appendix 8E, *Bromide,* Table 4). Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects changes in bromide due only to operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Tables 4 and 5). Such similarity demonstrates that the modeled Alternative 1A change in bromide is almost entirely due to Alternative 1A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless of whether Alternative 1A is compared to Existing Conditions, or compared to the No Action Alternative. Results of the modeling approach, which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*), differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 5). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 10% exceedance over the modeled period under Alternative 1A, as compared to 1% under Existing Conditions, and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 22% under Alternative 1A. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in the 100 μg/L exceedance frequency, would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. Drinking water treatment plants in this region utilize a variety of conventional and enhanced treatment systems to achieve DBP drinking water criteria. Depending on the necessary disinfection requirements surrounding removal of pathogenic organisms, as well as the aggregate quality of water such as pH and alkalinity, a change in long-term average bromide of the magnitude predicted may necessitate changes in treatment plant operation or treatment plant facilities in order to maintain DBP compliance. For example, for a water treatment plant utilizing ozone to achieve disinfection equivalent to 1 or 2 log inactivation of *Giardia*, an increase in long-term average bromide above 50 µg/L may require pH control systems (California Urban Water Agencies 1998:4-18). For a water treatment plant utilizing chlorine to achieve 1 or 2 log inactivation of *Giardia*, an increased frequency of bromide in excess 100 µg/L may require a switch to ozonation with pH control (California Urban Water Agencies 1998: 4-20). While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of health protection. This would be an adverse effect. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and city of Antioch are infrequently used because of water quality constraints related to sea water intrusion. On a long-term average, bromide at these locations exceeds 3,000 µg/L, but during seasonal periods of high Delta outflow levels can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and city of Antioch under Alternative 1A would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 173 µg/L (68% increase) at city of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide,* Table 25). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the city of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3, *Plan Area*), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 1A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 37% relative to Existing Conditions and 28% relative to the No Action Alternative. Relative changes in long-term average bromide concentrations would be less during drought conditions (≤31%), but would still represent considerable improvement (Appendix 8E, *Bromide,* Table 4). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in water quality would be experienced respective to bromide in the SWP/CVP Export Service Areas. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed because bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 5).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of bromide or contribute a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 1A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 1A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with separate, other commitments as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 1A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 1A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 1A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 1A would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 1A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 37% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 1A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 1A, water exported from the Delta to the SWP/CVP Export Service Areas would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 1A operation and maintenance activities would not cause substantial degradation to water quality respective to bromide in the Plan Area with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 38%, and 94% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 1A, while for the modeled drought period, the frequency would increase from 0% to 48%. Substantial changes in long-term average bromide could necessitate changes in water treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The modeled change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for significant impacts on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact would be significant.

Implementation of Mitigation Measure WQ-5 along with a separate, other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-5, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions; Site and Design Restoration Sites to Reduce Bromide Increases in Barker Slough

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 1A. Therefore, to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A. The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on bromide concentrations in Barker Slough. Design and siting of restoration areas shall attempt to reduce potential effects to the extent feasible without compromising proposed benefits of the restoration areas. It is anticipated that these efforts will be able to reduce the level of projected increase, though it is unknown whether it would be able to completely eliminate any increases.

Additionally, following commencement of initial operations of CM1, the project proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the increased bromide concentrations currently modeled to occur under Alternative 1A. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased bromide concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. If sufficient operational flexibility to offset bromide increases is not feasible under Alternative 1A operations, and/or siting and design of restoration areas cannot feasibly reduce bromide increases to a less-than-significant level without compromising the benefits of the proposed areas, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 1A would not present new or substantially changed sources of bromide to the study area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-5).

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

In summary, implementation of CM2–CM21 under Alternative 1A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 1A would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–CM21 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–CM21 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. This impact is therefore considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. Under Alternative 1A, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to Existing Conditions in association with climate change and increased water demands, and would remain virtually the same relative to No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). However, the small increases in lower San Joaquin River chloride levels that could occur under Alternative 1A, relative to Existing Conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 1A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling predicts that Alternative 1A would result in decreased long-term average chloride concentration at some assessment locations for the 16-year period modeled (i.e., 1976–1991), in particular at interior and south Delta assessment locations (i.e., San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough) (Appendix 8G, *Chloride*, Table Cl-7 and Table Cl-8) Long-term average chloride concentrations would remain relatively unchanged at the San Joaquin River at Antioch and Contra Costa Canal at Pumping Plant #1 locations, and, depending on modeling approach (see Section 8.3.1.3, *Plan Area*), would increase at the Sacramento River at Emmaton (i.e., ≤18%), Sacramento River at Mallard Island (i.e., ≤6%), North Bay Aqueduct at Barker Slough (i.e., ≤32%), and SF Mokelumne at Staten Island (i.e., ≤21%). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the

Bay source water as a result of increased salinity intrusion. More discussion of this the assessment methods for changes in source water concentrations caused by project-related hydrodynamic changes is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would have the greatest effect on the western Delta assessment locations which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 1A would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the Delta assessment locations (Appendix 8G, Table Cl-7). The increases in long-term average chloride concentrations would be largest compared to the No Action Alternative condition, ranging from 2% at the San Joaquin River at Buckley Cove to 36% at the North Bay Aqueduct at Barker Slough. The comparison to the No Action Alternative reflects chloride changes due only to operations.

The following discussion outlines the modeled chloride changes relative to Existing Conditions and the No Action Alternative regarding the applicable objectives and beneficial uses of Delta waters.

Municipal and Industrial Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 1A, the modeled frequency of objective exceedance would increase from 7% of modeled years under Existing Conditions, to 13% of modeled years under Alternative 1A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 1A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 1A (Appendix 8G, *Chloride*, Table Cl-63). Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would increase at the San Joaquin River at Antioch location from 66% under Existing Conditions to 74%, and would increase by 2% at the Sacramento River at Mallard Island location (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-9). The increased chloride concentrations at the Antioch and Mallard Slough locations would occur during the months of January through June, thus reducing water quality during the period of seasonal freshwater diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 66% for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-9). Similar to modeling results that predicted daily exceedance frequency, the frequency of monthly average exceedances at the Contra Costa Canal at Pumping Plant #1 would decrease (Appendix 8G, Table Cl-9); however, available assimilative capacity would be reduced compared to the Existing Conditions up to 100% in October (i.e., eliminated) (Appendix 8G, Table Cl-11). Additional long-term degradation at the Antioch and Contra Costa Canal at Pumping Plant #1 locations would occur when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Table Cl-10 and Table Cl-12). However, the predicted magnitude change at western Delta locations are substantially different when the predictions from both modeling approaches are compared. For example, both modeling approaches indicated that the frequency of exceeding the 250 mg/L objective at Contra Costa Canal at Pumping Plant #1 on a monthly average basis would decrease relative to Existing Conditions, but their predictions of the magnitude use of assimilative capacity varied substantially. Modeling using the mass balance approach predicted that 100% of assimilative capacity would be utilized in October, but modeling using the chloride-EC relationship approach predicted that only 20% of assimilative capacity would be utilized. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation and use of assimilative capacity, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Contra Costa Pumping Plant #1 and Antioch locations.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would generally be similar or lower compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2).

With respect to Suisun Marsh, the long-term average chloride concentration at the Sacramento River at Mallard Island for the 16-year period modeled would increase by 91 mg/L (4%) compared to Existing Conditions (Appendix 8G, Table Cl-7) and chloride concentrations would increase in some months during October through May at Mallard Island (Appendix 8G, Figure Cl-1) and in the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3). Monthly average chloride concentrations at the Montezuma Slough at Beldon's Landing would increase substantially compared to Existing Conditions in October through May, with over a doubling of concentrations in December through February (Appendix 8G, Figure Cl-4). Although modeling of Alternative 1A assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, *Electrical Conductivity*, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 1A, the modeled frequency of objective exceedance would increase from 0% under the No Action Alternative to 13% of years under Alternative 1A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where, daily average objectives apply. For Alternative 1A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 1A (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency of the 250 mg/L objective is predicted relative to the No Action Alternative would increase slightly by 1% at the Antioch location (i.e., from 73% to 74%),by 7% at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 21%), and by 1% at Mallard Island (i.e., from 86% to 87%) (Appendix 8G, *Chloride*, Table Cl-9). The available assimilative capacity for the 16-year period modeled would be reduced at the Antioch location during the months of February and March by approximately 28% and 44%, respectively, compared to the No Action Alternative (Appendix 8G, Table Cl-11). The available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in September through April compared to the No Action Alternative (i.e., reduction ranging from 18% in January up to 100%, or eliminated, in October), reflecting substantial degradation during the months October through December when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-10 and Table Cl-12). But like the assessment relative to Existing Conditions, the predicted magnitude change at western Delta locations are substantially different. For example, both modeling approaches indicated that the frequency of exceeding the 250 mg/L objective at Contra Costa Pumping Plant #1 on a monthly average basis would increase slightly or remain unchanged relative to the No Action Alternative. Modeling using the mass balance approach predicted that 100% of assimilative capacity would be utilized in October, but modeling using the chloride-EC relationship approach predicted that only 35% would be utilized under the No Action Alternative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of one of both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Antioch intake, through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride for Tom Paine Slough, relative to the No Action Alternative, monthly average chloride concentrations at Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would not be further degraded under Alternative 1A (Appendix 8G, Figure Cl-2).

Modeling results indicate that concentrations at source water channel locations for the Suisun Marsh would increase in some months during October through May compared to the No Action Alternative (Appendix 8G, Figures Cl-1, Cl-3, and Cl-4). Sensitivity analyses suggested that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 1A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 32% relative to Existing Conditions and 20% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-7). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-9). Consequently, water exported to the SWP/CVP service area would generally be of similar or better quality with regard to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-8 and Table Cl-10).

Commensurate with the decrease in chloride concentrations exported to the San Joaquin Valley for agricultural irrigation, an improvement in lower San Joaquin River chloride would also be anticipated to occur because chloride loading from agricultural drainage would be reduced. While difficult to predict, the relative decrease in overall loading of chloride to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected.

NEPA Effects: In summary, relative to the No Action Alternative, Alternative 1A would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and could contribute measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative indicate that implementation of CM1 and CM4 under Alternative 1A would contribute substantially to the adverse water quality effects (i.e., impacts are not wholly attributable to the effects of climate change/sea level rise).

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 1A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 1A would result in substantially increased chloride concentrations in the Delta such that frequency of exceedances of the 150 mg/L Bay-Delta WQCP objective would approximately double. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at Antioch (by 8%) and at Mallard Slough (by 2%) which could result in significant impacts on the municipal and industrial water supply beneficial use at these locations (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, further long-term degradation would occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives. Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. However, based on sensitivity analyses conducted to date (see Appendix 8H, *Electrical Conductivity*, Attachment 1), it is expected that implementation of Mitigation Measure WQ-7d would reduce impacts on chloride in Suisun Marsh to a less-than-significant level.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 1A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact would be significant due to increased chloride concentrations and degradation at western Delta locations and its impacts on municipal and industrial water supply and fish and wildlife beneficial uses.

Implementation of Mitigation Measure WQ-7 along with a separate, other commitment relating to the potential increased costs associated with chloride-related changes would reduce these effects. Although it is not known whether implementation of WQ-7 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of Mitigation Measure WQ-7d would reduce impacts on chloride in Suisun Marsh to a less-than-significant level.

In addition to and to supplement Mitigation Measure WQ-7, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations and/or site-specific design of tidal restoration areas under CM4. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.

Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation shall continue to monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. DWR and Reclamation have a good history of compliance with water quality objectives (see Sections 8.1.3.4 and 8.1.3.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in Sections 8.3.1.1, *Models Used and Their Linkages*, and 8.3.1.3, *Plan Area*), it is likely that objective exceedance, should any be predicted to occur, could be avoided through real-time operation of the SWP and CVP.

Nevertheless, water quality degradation could occur that may not be addressed through real-time operations. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure WQ-7a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The project proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation relative to the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 1A. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-7b. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 1A.

Mitigation Measure WQ-7b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation with respect to the 250 mg/L chloride objective in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-7a. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 1A.

Mitigation Measure WQ-7c: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets Applicable Water Quality Objectives

To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the project proponents will consult with the purveyors to identify any feasible operational means to either avoid, minimize, or offset for reduced seasonal availability of water that either meets applicable water quality objectives or that results in levels of degradation that do not substantially increase the risk of adversely affecting the municipal and industrial beneficial use. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any potentially feasible actions described in Mitigation Measure WQ-7a and WQ-7b.

Mitigation Measure WQ-7d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce Chloride Concentration Increases in the Marsh

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. The project proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. These actions are identical to the actions discussed in Mitigation Measure WQ-11b regarding levels of electrical conductivity in Suisun Marsh.

Mitigation Measure WQ-7e: Implement Terms of the Contra Costa Water District Settlement Agreement

DWR and Contra Costa Water District (CCWD) entered into a settlement agreement (Agreement) for reducing potential impacts to water supply in the Delta related to construction and operation of the BDCP/California WaterFix. This mitigation measure includes conveyance of water to CCWD that meets specified water quality requirements, in quantities and on a schedule defined in the Agreement. The Agreement ensures that the quality of the water CCWD delivers to its customers is not impacted as a result of the BDCP/California WaterFix. The Agreement does not increase the total amount of water that CCWD would otherwise be entitled to divert.

DWR would convey mitigation water to CCWD in one of two ways: 1) the primary method of conveying the water would be through the existing Freeport Regional Water Authority Intake (Freeport Intake) and the existing interconnection between EBMUD's Mokelumne Aqueduct and CCWD's Los Vaqueros Pipeline; and 2) the secondary method of conveying the water would be through the BDCP/California WaterFix's northern intakes and new Interconnection Facilities between the water conveyance facilities and existing CCWD facilities. Two different options for the new Interconnection Facilities are being considered: one on Victoria Island between the water conveyance facilities and the existing CCWD Middle River pipeline; and one at Clifton Court Forebay between the Clifton Court Forebay and the CCWD Los Vaqueros pipeline. No new facilities are required for the EBMUD/Freeport Intake conveyance method. DWR would be responsible for design and construction of the Victoria Island or Clifton Court Forebay facilities.

The Agreement requires an initial conveyance to CCWD of 30 TAF of water. For each year after the initial conveyance, a specified amount of water based on the prior year's operations would be conveyed in arrears. Under the Agreement, CCWD would take the same quantity of water that it would take absent the agreement, but the location and timing of diversions would change. Annual average diversions of mitigation water would be on the order of 30 TAF, and the rate of diversion of the mitigation water would be 150 cfs, with a maximum rate of diversion of 250 cfs upon mutual agreement between DWR and CCWD.

Additional description of the Agreement actions and analysis of the potential effects of this mitigation measures are provided in Appendix 31B. Terms of the Agreement are presented in Attachment 1 to Appendix 31B.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** The implementation of the other conservation measures (i.e., CM2–CM21), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/ CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12–CM21 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of CM2–CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions.

***CEQA Conclusion*:** Implementation of the CM2–CM21 for Alternative 1A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial decreases in DO levels in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any minor decreases in DO levels that could occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses within the Upstream of the Delta Region, or substantially degrade the quality of these water bodies, with regard to DO.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial decreases in DO levels in the Delta relative to Existing Conditions and the No Action Alternative. Any minor decreases in DO levels that could occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses in the Plan Area, or substantially degrade the quality of these water bodies, with regard to DO.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions as it would consist of water directly withdrawn from the Delta at the current export pumps and water diverted from the Sacramento River at Hood. DO levels in the vicinity of the south Delta export pumps may be reduced occasionally, but would not be anticipated to be substantially lower at this location on a long-term basis, relative to Existing Conditions. The DO levels in water entering the canals from the new facilities that diverted the water from the Sacramento River at Hood would be expected to be equal to or higher than DO levels at the south Delta export pumps, and would be expected to have similar or lower levels of oxygen demanding substances. Hence, the typical DO level of water entering the SWP/CVP Export Service Areas waters would not be expected to be substantially lower than that under Existing Conditions. DO dynamics within the exposed canals and the downstream reservoirs would remain similar to that under Existing Conditions. Consequently, effects on DO levels in the SWP/CVP Export Service Areas would not be adverse under Alternative 1A relative to Existing Conditions.

NEPA Effects: For the same reasons given above, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas are not expected to occur under Alternative 1A relative to the No Action Alternative. The effects on DO from implementing CM1 would not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 1A would be similar to those discussed for the No Action Alternative, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the No Action Alternative.

Reservoir storage reductions that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 1A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and the action of plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta. CM13 proposes to use a variety of methods to control invasive aquatic plants, of which herbicide spraying is one option. The area of treatment that would be funded by the conservation measure would be 1,700–3,300 acres (see Section 3.6.3.2 of Chapter 3, *Description of Alternatives*), a limited area relative to the entire area of the Delta surface waters. Further, as described in Section 3.6.3.2 of Chapter 3, avoidance and minimization measures would be adopted and would likely be similar to those conditions identified in the existing California Department of Boating and Waterways (CDBW) program (including the associated biological opinion and EIR), which restrict where and when herbicide treatment may occur, establish allowable chemical concentrations in treated areas and adjacent water, and require extensive water quality monitoring. Thus, based on the size of the area to be treated and the measures to be used, this conservation is not considered to have an adverse effect on DO in the Delta that would adversely affect beneficial uses. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances. The effects on DO from implementing CM2–CM21 would not be adverse.

CEQA Conclusion: It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–CM21 under Alternative 1A would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 1A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that may occur under Alternative 1A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling indicates that Alternative 1A would result in an increase in the number of days when Bay-Delta WQCP compliance locations would exceed EC objectives or be out of compliance with the EC objectives at the Sacramento River at Emmaton and San Joaquin River at Jersey Point (fish and wildlife objective) in the western Delta, the San Joaquin River at San Andreas Landing in the interior Delta, and Brandt Bridge in the southern Delta (Appendix 8H, *Electrical Conductivity*, Table EC-1).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 31% under Alternative 1A. Further, the percentage of days out of compliance at Emmaton would increase from 11% under Existing Conditions to 45% under Alternative 1A.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 3% under Alternative 1A. Further, the percentage of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 6% under Alternative 1A. Sensitivity analyses were performed for Alternative 4 Scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

At Jersey Point, relative to the fish and wildlife objective, the percentage of days of EC objective exceedance and days out of compliance would increase from 0% under Existing Conditions to 3% under Alternative 1A, which represents a very small increase for this objective. Further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2.

At Brandt Bridge, the increase in days of EC objective exceedance and days out of compliance would be <1%. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–27% for the entire period modeled and 2–28% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-12). At Emmaton, average EC would increase 16% for both the entire period modeled and the drought period modeled. Also, at the two interior Delta compliance locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire and drought periods modeled. On average, EC would increase at Emmaton during all months except October and November. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase 15% for the entire period modeled (Appendix 8H, Table EC-12; further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean Water Act Section 303(d) listed sections of the Delta–western, northwestern, and southern–the Sacramento River at Emmaton would have a modest increase in exceedance of the Bay-Delta WQCP EC objectives (25%) and the San Joaquin River at Brandt Bridge in the southern Delta would have a slight increase (<1%) in the exceedance of the Bay-Delta WQCP EC objectives (Appendix 8H, Table EC-1). Further, long-term average EC at Emmaton would increase by 16%, whereas the long-term average EC at Brandt Bridge would decrease by 2%, relative to Existing Conditions, for the entire period modeled (Appendix 8H, Table EC-12). Thus, Alternative 1A is not expected to contribute to additional impairment and adversely affect beneficial uses for Section 303(d) listed southern Delta waterways, relative to Existing Conditions. However, the increase in incidence of exceedance of EC objectives and increases in long-term and drought period average EC at Emmaton in the western Delta, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Brandt Bridge, and Prisoners Point; and Old River near Middle River at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-1). The increase in percentage of days exceeding the EC objective would be 2% or less and the increase in percentage of days out of compliance would be 5% or less, with the exception of Emmaton, which would have a 17% increase in percentage of days exceeding the EC objective and 20% increase in percentage of days out of compliance. Regarding exceedances at Old River at Middle River and at Tracy Bridge, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (15%), San Joaquin River at Jersey Point (3%), S. Fork Mokelumne River at Terminous (5%), San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-12). For the drought period modeled, the locations with an average EC increase would be: Sacramento River at Emmaton (5%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy

Bridge (1%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-12). The western and southern Delta are CWA Section 303(d) listed for elevated EC and the increased incidence of exceedance of EC objectives and EC degradation that could occur in the western Delta could make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC for the entire period modeled would increase under Alternative 1A, relative to Existing Conditions, during the months of February through May by 0.1–0.8 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon's Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.9–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses.

Long-term average EC increases in Suisun Marsh under Alternative 1A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is Clean Water Act Section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 1A would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under Alternative 1A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 1A would decrease 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 16% for the entire period modeled and 13% during the drought period modeled. (Appendix 8H, Table EC-12)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 1A would decrease 19% for the entire period modeled and 17% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 15% for the entire period modeled and 13% during the drought period modeled. (Appendix 8H, Table EC-12)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 1A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 1A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 1A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

***NEPA Effects*:** In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under Alternative 1A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA Section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is Section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 1A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 1A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the Sacramento River at Emmaton (25%; western Delta) for the entire period modeled (1976–1991). For the entire and drought periods modeled, average EC levels would increase by 12% at San Andreas Landing and by 16% at Emmaton. In addition, there would be an increase in the average EC at Jersey Point of 15% (for the entire period modeled) during the months of April–May, when the fish and wildlife objective applies. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act Section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 1A could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act Section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant. However, based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of Mitigation Measure WQ-11d would reduce impacts on EC in Suisun Marsh to a less-than-significant level.

Implementation of Mitigation Measure WQ-11 along with a separate, other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. Although it is not known whether implementation of WQ-11 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of Mitigation Measure WQ-11d would reduce impacts on EC in Suisun Marsh to a less-than-significant level.

In addition to and to supplement Mitigation Measure WQ-11, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments, AMMs and CMs*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

In order to reduce the effects of increased EC levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate feasible actions, followed by development and implementation of the actions, if determined to be necessary. The emphasis and mitigation actions would be limited to those identified as necessary to avoid, reduce, or offset adverse EC effects at Delta compliance locations and the Suisun Marsh. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental EC effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A. The goal of specific actions would be to reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average concentration increases to levels that would not adversely affect beneficial uses within the Delta and Suisun Marsh.

Mitigation Measure WQ-11a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The project proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation in the western Delta currently modeled to occur under Alternative 1A. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-11b. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 1A. These actions are identical to the actions discussed in Mitigation Measure WQ-7a regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 1A. These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11c: Design Restoration Sites to Reduce Effects on Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to Determine Whether Additional Actions are Warranted

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on compliance with the fish and wildlife EC objective between Jersey Point and Prisoners point on the San Joaquin River. Design of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. Additionally, following commencement of initial operations of CM1, the project proponents will evaluate ongoing monitoring of striped bass populations, and, specifically spawning in the San Joaquin River between Jersey Point and Prisoners Point, and will conduct such monitoring if it is not already being conducted by CDFW at that time. The project proponents will consult with CDFW, USFWS, and NMFS to determine whether adaptive changes to Head of Old River Barrier operations and/or changes in North Delta vs. South Delta exports are warranted to avoid adverse impacts of salinity on striped bass spawning in the San Joaquin River. Because these actions may have adverse effects on other species, consultation is required, and the changes may not be warranted depending on conditions of striped bass populations and populations of other species at that time.

Mitigation Measure WQ-11d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce EC Level Increases in the Marsh

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. The project proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased EC levels. These actions are identical to the actions discussed in Mitigation Measure WQ-7c regarding levels of chloride in Suisun Marsh.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM21) present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–CM21 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment. The effects on EC from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 1A would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–CM21 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of CM2–CM21 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 1A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 1A.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury relative to the 25 ng/L ecological risk benchmark of Alternative 1A showed the greatest decrease to be 1% at Franks Tract and Old River relative to Existing Conditions, and 1.1% at Franks Tract relative to the No Action Alternative (Figures 8-53a and 8-54a). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration were very small. The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions and the same as the No Action Alternative (Appendix 8I, *Mercury*, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase was at Mokelumne River (South Fork) at Staten Island (8% relative to Existing Conditions and 10% relative to the No Action Alternative) (Figures 8-55a and8-55b; Appendix 8I, *Mercury*, Table I-8b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 1A are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-2 and I-3). Therefore, mercury and methlymercury show increased assimilative capacity at these locations (Figures 8-53a and 8-54a).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 1A, at any location within the Delta relative to Existing Conditions and the No Action Alternative are expected for the export pump locations (specifically, at Banks Pumping plant, 9% improvement relative to Existing Conditions, 11% relative to the No Action Alternative) (Figures 8-55a and 8-55b; Appendix 8I, *Mercury*, Tables I-8a, b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 1A to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 1A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 1A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 1A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 1A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Some habitat restoration activities under Alternative 1A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 1A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Increased methylmercury due to the restoration areas would constitute an additional loading of methylmercury to the Delta, independent of effects of the hydrodynamics associated with the restoration areas. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 1A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3, *Plan Area*) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 1A.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site (this approach could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, this would run directly counter to the goals and objectives of the BDCP. This approach should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas),
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in waterborne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 1A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, adverse effects on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed, relative to Existing Conditions and the No Action Alternative.

Under Alternative 1A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 1A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area,* for more information.

Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 7 and 8). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 1A, relative to Existing Conditions, and would be nearly the same (i.e., any increase would be negligible) as that under the No Action

Alternative. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions, and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months (Appendix 8J, Table 9).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Regional Water Quality Control Board 2010a:32).
- Under Alternative 1A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 1A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification upgrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 1A, the increase is expected to be greater under Existing Conditions than for Alternative 1A due to the upgrades that are assumed under Alternative 1A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Table 7 and 8). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Appendix 8J, Table 9).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***NEPA Effects*:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 1A are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM21 is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

The effects on nitrate from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 under Alternative 1A, relative to Existing Conditions. Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 1A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, Alternative 1A would result in small increases (i.e., between 1 and 9%) in long-term average DOC concentrations at some interior Delta locations. In particular, modeled increases in long-term average DOC would be greatest at Franks Tract, with net average DOC concentration increases for the 16-year (1976–1991) hydrologic period modeled of 0.3 mg/L, equivalent to an approximate 9% relative increase (0.2 mg/L for the drought period, 8% relative increase) (Appendix 8K, *Organic Carbon*, DOC Table 2). Long-term increases of not greater than 0.3 mg/L (≤8%) would be predicted to occur at Staten Island, Rock Slough, and Contra Costa PP No. 1 as well. At all 11 assessment locations, modeled long-term average DOC concentrations exceed 2 mg/L 92-100% of the time. However, increases in long-term average DOC in the Delta interior would result in more frequent exceedances of the 3 mg/L concentration threshold, with the largest magnitude effect occurring at Rock Slough and Contra Costa PP No. 1. At Rock Slough, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under

Existing Conditions to 66% under Alternative 1A (an increase from 47% to 63% for the drought period). At Contra Costa PP No. 1, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under Existing Conditions to 68% under Alternative 1A (an increase from 45% to 67% for the drought period). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at Rock Slough and Contra Costa PP No. 1 would be small. At Rock Slough, an increase in the frequency long-term average DOC would exceed 4 mg/L would only occur for the drought period, increasing from 32% under Existing Conditions to 40% under Alternative 1A, while at Contra Costa PP No.1 the modeled exceedance frequency for the 16-year hydrologic period would rise from 32% to 34% (an increase from 35% to 42% for the drought period). Concentration threshold exceedances at the other assessment locations would be similar or less. While Alternative 1A would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

In comparison, Alternative 1A relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of not greater than 0.3 mg/L DOC (i.e., ≤9%) would be predicted at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1(Appendix 8K, *Organic Carbon*, DOC Table 2). Threshold concentration exceedance frequency trends would also be similar to those discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 62% for the modeled drought period). While the Alternative 1A would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to the No Action Alternative, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 1A operations.

The Stage 1 Disinfectants and Disinfection Byproduct Rule adopted by U.S. EPA in 1998, as part of the Safe Drinking Water Act, requires drinking water utilities to reduce TOC concentrations by specified percentages prior to disinfection. EPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. These requirements were adopted because organic carbon, such as DOC, can react with disinfectants during the water treatment disinfection process to form DBPs, such as THMs which pose potential lifetime carcinogenic risks to humans. Moreover, a CUWA convened expert panel reviewed Delta source water quality and DBP formation potential in an effort to develop Delta source water quality targets for treated drinking water. This panel found that source water between 4 and 7 mg/L TOC would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for DBPs.

Water treatment plants that utilize Delta water are currently designed and operated to meet EPA's 1998 requirements based on the ambient concentrations and seasonal variability that currently exists in the Delta. Substantial changes in ambient DOC concentrations would need to occur for significant changes in plant design or operations to be triggered. The increases in long-term average

DOC concentrations estimated to occur at various Delta locations under Alternative 1A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to Existing Conditions and No Action Alternative conditions, Alternative 1A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 1A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L at both pumping plants, although in drought years the decrease would be 0.1 mg/L at Banks pumping plant and <0.1 mg/L at Jones pumping plant (Appendix 8K, *Organic Carbon*, DOC Table 2). Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to 88% under Alternative 1A, while at the Jones pumping plant, exceedance frequency would increase from 72% to 87%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks, while at Jones pumping plant the exceedance frequency for the 4 mg/L threshold would decrease. Comparisons to the No Action Alternative yield similar trends, but with slightly small magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although somewhat more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects**:** In summary, Alternative 1A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.3 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this

constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 1A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 1A would result in relatively small increases (i.e., ≤9%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Staten Island, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 1A would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 1A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 0.4 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted during periods of drought. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 1A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: The mostly non-land disturbing CM12–CM21 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–CM21 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measure activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well as highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils.

Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 1A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Implementation of CM2, CM3, CM8, CM9, and CM11–CM21 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8, CM9, and CM11–CM21. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments,* *AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, this could include designing wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized "hot spots" and net Delta loading.

Establish measures to help guide the design and creation of the target wetland habitats. At a minimum, the measures should limit potential increases in long-term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland and riparian habitat features, consistent with the biological goals and objectives of the BDCP. For example, restoration activities could be designed and located with the goal of preventing, consistent with the biological goals and objectives of the BDCP, net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

However, it must be noted that some of these measures could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, these measures would run directly counter to the goals and objectives of the BDCP. This mitigation measure should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas. As mentioned above, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial, and would likely result in immeasurable, increases in pathogen concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action

Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial, and would likely result in immeasurable, increases in pathogen concentrations in the Delta region relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions and the No Action Alternative, as it would consist of water diverted from the Sacramento River at Hood in addition to the water directly withdrawn from the Delta at the current export pumps.

The Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-7) reports the median *E. coli* concentration in the Sacramento River at Hood is the same order of magnitude (10^1) as the median *E. coli* concentration at the Contra Costa Water District's Pumping Plant #1 and the Delta Pumping Plant Headworks (referred to herein as the Banks pumping plant), with the median Banks pumping plant concentrations being higher than the Sacramento River and Pumping Plant #1 median concentrations (data for comparison of total coliforms and fecal coliforms is not presented in Tetra Tech 2007 and, thus, only *E. coli* is discussed). Based on the Pathogen Conceptual Model's findings that Delta *E. coli* concentrations appear to be largely influenced by localized sources and that Sacramento River *E. coli* concentrations are lower than Delta concentrations, the diversion of Sacramento River water at Hood is not expected to measurably increase the *E. coli* concentration in the SWP/CVP Export Service Areas waters.

Furthermore, the following average pathogen concentrations for the Sacramento River at River Mile 44 (which is upstream of Hood and downstream of the Sacramento Regional Wastewater Treatment Plant) are reported in the Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-4):

Cryptosporidium: 0.12 oocysts/L (31% of samples detected)

Giardia: 0.9 cysts/L ml (66% of samples detected)

Pathogen concentrations in SWP/CVP Export Service Areas waters, particularly *Giardia* and *Cryptosporidium* concentrations, are of concern because the concentration of these pathogens dictates the level treatment required for the drinking water supply. The *California State Water Project Sanitary Survey, 2006 Update* (State Water Project Contractors Authority 2007) reported *Giardia* and *Cryptosporidium* concentrations for locations throughout the SWP. These pathogens were not frequently detected and the concentrations reported were such that the waters would be classified as "Bin 1" under the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), meaning no additional treatment required under the Rule, though some waters required additional monitoring to confirm this classification. Based on the levels of *Cryptosporidium* in the Sacramento River, this alternative would not be expected to adversely affect the municipal and domestic water supply uses in the service areas, as the water would be classified as "Bin 1" with respect to the LT2ESWTR, meaning no additional treatment required.

With respect to the remaining beneficial uses in the service area (e.g., recreation), an increased proportion of water coming from the Sacramento River would not adversely affect those uses in the SWP/CVP Export Service Areas. As described above, the pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations (Tetra Tech 2007). Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

For the same reasons stated for the No Action Alternative, Alternative 1A is expected to have minimal effects on pathogen concentrations in SWP/CVP Export Service Areas waters relative to Existing Conditions and No Action Alternative.

NEPA Effects: The effects on pathogens from implementing CM1 is determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM11 would involve habitat restoration actions, and CM21 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to the No Action Alternative. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources. The effects on pathogens from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11 and CM21 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 1A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 1A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito, and the San Joaquin River at Vernalis would change. Averaged over the entire period of record, seasonal average flow rates on the Sacramento would decrease no more than 7% during the summer and 2% during the winter relative to Existing Conditions (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease by as much as 5% during the summer, but would increase by as much as 12% in the winter, while on the American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter relative to Existing Conditions. In comparison to the No Action Alternative, the relative magnitude change in seasonal average flows would be similar, with exception to the estimated change on the American River and San Joaquin River relative to No Action Alternative. In comparison to No Action Alternative, there would be no estimated change in season average flows on the San Joaquin River (i.e., 0% summer and winter change) and there would only be a 1% decrease of summer average flows on the American River.

For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 1A, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 1A modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, *Source Water Fingerprinting Results*). At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13–15% during February and March. San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14–16% during February and March at Rock Slough and 13–17% during March and April at Contra Costa PP No. 1. Sacramento River fractions would increase greater than 10% at Buckley Cove as well. At Buckley Cove, Sacramento River source water fractions when modeled for the 16-year hydrologic period would increase by 11% during August, and 11–14% during July and August during the modeled drought period. Relative to Existing Conditions, there would be no modeled increases in Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. This comparison to Existing Conditions reflects changes in Delta source water fractions due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 26% in August when compared to No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects changes in Delta source water fractions due only to Alternative 1A operations.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 1A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). Source water fractions would generally increase from 13–53% for the period of December through June for the modeled 16-year hydrologic period and 13–40% from the period of March through May for the modeled drought period. These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River fraction. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 1A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 1A, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 1A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 1A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

With the exception of CM13, the mostly non-land disturbing CM12–CM21 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by CDBW. The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board, US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

NEPA Effects: In summary, CM13 of Alternative 1A proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could adversely affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

CEQA Conclusion: With the exception of CM13, implementation of CM2–CM21 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with

CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby significant effects on beneficial uses would be expected. CM2–CM21 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant and unavoidable. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, no feasible mitigation is available that would reduce it to a level that would be less than significant. This impact is therefore considered significant and unavoidable.

Mitigation Measure WQ-22: Implement Principals of Integrated Pest Management

Implement the principals of integrated pest management (IPM) in the management of invasive aquatic vegetation under CM13, including the selective use of pesticides applied in a manner that minimizes risks to human health, nontarget organisms and the aquatic ecosystem. In doing so, the project proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as selective application of pesticides, timing of applications in order to minimize tidal dispersion, and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may affect phosphorus levels are discussed below.

Upstream of the Delta

The conveyance facilities operations and maintenance (CM1) for Alternative 1A will not contribute additional sources of phosphorus to the water bodies upstream of the Delta. Because phosphorus loading to waters upstream of the Delta is not anticipated to change under Alternative 1A, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, as discussed for the No Action Alternative, substantial changes in phosphorus concentration are not anticipated in any of the water bodies of the affected environment located upstream of the Delta under Alternative 1A, relative to Existing Conditions or the No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in these water bodies would not be of frequency, magnitude and geographic extent that would exceed adopted phosphorus objectives/criteria (because there are none), adversely affect any beneficial uses, or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

As discussed for the No Action Alternative, because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Additionally, activities associated with CM1 will not contribute additional sources of phosphorus to the Delta. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations show in Figure 8-56, the magnitude of increase during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives for phosphorus, and because algal growth rates are limited by availability of light in the Delta, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the Delta are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

Assessment of effects of phosphorus in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations show in Figure 8-56, long-term average monthly and annual phosphorus concentrations at Banks and Jones pumping plants are anticipated to decrease as a result of Sacramento River water replacing San Joaquin River water in exports. During drought conditions, phosphorus concentrations may increase during certain months, but these increases are expected to be negligible (<0.01 mg/L). There are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

NEPA Effects: The effects on phosphorus from implementing CM1 are determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 1A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 1A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 1A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while ortho-phosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–CM21. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM21 is not expected to substantially alter phosphorus concentrations in the affected environment.

The effects on phosphorus from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 under Alternative 1A relative to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 1A, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-11 and M-21 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 1A would result in little to no changes in long-term average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.02 µg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (2% or less) in available assimilative capacity for selenium, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 1A (range 0.09–0.38 µg/L) would be similar to those for Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and all would be below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very small changes (1% or less) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-21). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 12% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.3 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 7% in all years (from about 4.4 to 4.7 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2% or 3% at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative), and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 1A would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 1A in the East Delta are expected to increase by more than 8 days (Table 8-60a). Relative to the No Action Alternative, annual average residence times for Alternative 1A in the Cache Slough are expected to increase by up to 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the East Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the waterborne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 2 days relative to Existing Conditions, and 5 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in essentially no change in selenium concentrations throughout the Delta for most biota (approximately 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for adverse effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 1A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 1A would result in small (0.05–0.06 µg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, Table M-9a). These decreases in selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 6–7%, relative to the 1.3 µg/L benchmark (Figures 8-59a and 8-60a). Furthermore, the long-term average selenium concentrations in water for Alternative 1A (range 0.15–0.2 µg/L) would be well below the USEPA draft water quality criterion of 1.3 µg/L (Table M-9a in Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-21) at the Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative 1A (Figures 8-61a through 8-64b).

NEPA Effects**:** Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 1A are not considered to be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010d] and State Water Board [2010b, 2010c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 1A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.1 for Alternative 1A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for adverse effects. Overall, Alternative 1A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 1A would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality selenium concentrations of water in at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 1A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Appendix 8M; Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM21 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

As discussed in Impact WQ-25, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 2 days relative to Existing Conditions, and 5 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.

The South Delta receives elevated selenium loads from the San Joaquin River, and as Table 8-60a shows, residence times in this area are expected to increase on an annual average by 11 days relative to Existing Conditions, and 9 days relative to the No Action Alternative. However, as discussed in Impact WQ-25, biota concentrations in the South Delta are not approaching levels of concern. Furthermore, in contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but to a lesser degree than the overbite clam (Lee et al. 2006). Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium. Given the available information, these increases are small enough that they are not expected to cause selenium concentrations in biota in the south Delta to approach or exceed thresholds of concern.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, *Biological Goals and Objectives*). Thus, these areas can be thought of as "flow-through" systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent feasible potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments, AMMs, and CMs,* for a description of the environmental commitment project proponents are making with respect to Selenium Management; and Appendix 3.C of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*: **There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C of the BDCP for more detail on AMM27) also described as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 1A, relative to Existing Conditions and the No Action Alternative. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 1A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 1A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 1A.

The assessment of the Alternative 1A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 1A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Implementation of CM2–CM21 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 1A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 1A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

ImpactWQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A is expected to have minimal effect on TSS concentrations and turbidity levels (highs, lows, typical conditions) in reservoirs and rivers upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any minor increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the Upstream of the Delta Region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

Delta

The TSS concentrations and turbidity levels of Delta inflows under operational and maintenance conditions of Alternative 1A are not expected to be substantially different from those occurring under Existing Conditions or would occur under the No Action Alternative. However, the implementation of this alternative would change the quantity of Delta inflows, which would affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. Localized changes in TSS concentrations and turbidity levels could occur, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Because the diversions would not substantially affect flows in high storm events, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions or the No Action Alternative. Consequently, any notable increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would likely be short-term in nature and long-term changes under this alternative would not be of sufficient frequency, magnitude and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions and the No Action Alternative, as it would consist of water diverted directly from the Sacramento River at Hood in addition to water withdrawn from the Delta at the current export pumps. Historical median turbidity levels in the Sacramento River at Hood (11 NTU) and in the Delta waters at the Harvey O. Banks Pumping Plant Headworks (11 NTU) are similar (Figure 8-47) and mean turbidity levels differ by 5 NTU (13 NTU at Banks pumping plant and 18 NTU in the Sacramento River at Hood). Thus, it is expected that the TSS concentrations and turbidity levels in the vicinity of the south Delta export pumps would not be substantially different from the levels under the Existing Conditions or the No Action Alternative. Consequently, the increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

***NEPA Effects*:** The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Changes river flow rate and reservoir storage that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 1A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under the No Action Alternative.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to the No Action Alternative. The remaining conservation measures (i.e., CM12–CM18, CM20–CM21) would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

***CEQA Conclusion*:** It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–CM21 under Alternative 1A would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–CM21, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. Under Alternative 1A, the majority of construction-related activities for CM1–CM21 would occur within the Delta. Few, if any, of the CM1–CM21 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: 1) *CM2 Yolo Bypass Fisheries Enhancement* (i.e., the Fremont Weir component of the action), 2) *CM18 Conservation Hatcheries* (i.e., the new hatchery facility), and 3) *CM19 Urban Stormwater Treatment*.

Within the Delta, the construction-related activities for Alternative 1A would be most extensive for CM1 involving the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, reusable tunnel material (RTM) dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the Byron Tract Forebay, canal and gates between the Byron Tract Forebay tunnel shafts and the approach canal to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly 4 years to complete.

Habitat restoration activities in the Delta (i.e., CM4–CM10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, also would involve substantial in-water construction-related activities across widespread areas of the Delta. Construction activities also would occur for CM2 in the Yolo Bypass to implement fish enhancement features. Anticipated construction activities that may occur under CM11–CM21, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

NEPA Effects: The types of potential construction-related materials used, soil and vegetation disturbance activities, potential contaminants associated with implementation of CM1–CM21 under Alternative 1A would result in similar potential contaminant discharges to water bodies and associated water quality effects to those discussed above for the No Action Alternative. Construction activities also may result in temporary or permanent changes in stormwater drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation. However, relative to Existing Conditions and the No Action Alternative conditions, these additional major land and in-water disturbances and related site development activities would be more widespread than non-BDCP projects, and therefore would increase the potential to cause direct discharges and stormwater runoff of contaminants to adjacent water bodies, particularly during the rainy season (generally October to April in California).

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies. Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4–CM10 would likely involve a variety of extensive conventional clearing and grading activities on relatively dry sites that are currently separated from the Delta channels by levees, construction of extensive new setback levees, excavation and soil placement for new wetland and other habitat feature development, and a variety of potential in-water construction activities such as excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated sediment or dredge material. Construction activities for the proposed restoration sites, due to the direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil and construction-related contaminants, or indirectly through erosion and site inundation during the weeks or months following construction prior to stabilization of newly contoured and restored landforms and colonization by vegetation.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Construction would involve extensive excavation/trenching and other subsurface construction activities, trenching, or work in or near Delta channels requiring site-dewatering operations to isolate the construction site from surface and groundwater. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.
- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce DO levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.
- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.
- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.

- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Construction-related activities may contribute to the discharge of contaminants such as PAHs which may be bioaccumulative in aquatic organisms, and construction-related disturbances may contribute to discharge of contaminants in soils and sediments in the Delta that are associated with existing impairments identified for Delta water bodies on the state's Section 303(d) list.

For the purposes of this assessment, it is assumed that construction activities conducted for Alternative 1A would be conducted in conformance to applicable federal and state regulations pertaining to grading and erosion control, and contaminant spill control and response measures. The construction-related environmental commitments for water quality protection, as identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, would be implemented by the project proponents. The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented for Alternative 1A to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 1A would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

In particular, construction-related activities under Alternative 1A would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants from facilities related to construction to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). This General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required Permit Registration Documents (PRDs) that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains Numeric Action Levels (NALs) for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*), for which Appendix 3B identifies specific BMPs within these categories (See commitments to Develop and Implement Stormwater Pollution Prevention Plans and Develop and Implement Erosion and Sediment Control Plans):

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.

- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.

- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.

- Construction Site Dewatering and Pipeline Testing (BMP category A.8). Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.

- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category "A" BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments, AMMs, and CMs*), BMPs implemented for Alternative 1A also would include the Category "B" BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category "C" BMPs (In-Water Construction BMPs) and Category "D" BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category "E" BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific conservation measures, which as described for the No Action Alternative, may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 1A would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges under the Alternative 1A would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, with respect to the Existing Conditions and No Action Alternative conditions, Alternative 1A would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: In summary, with implementation of environmental commitments in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, the potential construction-related water quality effects with respect to the Existing Conditions are considered to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions and the No Action Alternative, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under Alternative 1A. Consequently, any modified reservoir operations under Alternative 1A are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related changes of water residence times and its effects on *Microcystis* production (i.e., CM1). Other effects of CM2 through CM21 not attributable to hydrodynamics are discussed within the impact header for CM2 through CM21.

Under Alternative 1A, modeled residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through October show varying levels of change, depending on sub-region and timeframe (Table 8-60a). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions, because of climate change and sea level rise, the change is fairly small in most areas of the Delta. Below, residence times under Alternative 1A is compared to residence times under the No Action Alternative to remove the effect of climate change and sea level rise, thereby revealing the effect due to CM1 (i.e., operations) and the effect of the CM2 and CM4 restoration areas, which were accounted for in the modeling performed for CM1.

Water residence time in the North Delta and West Delta are projected to increase in both the summer and fall periods by 11 and 8 days, respectively, compared to the No Action Alternative. During the summer period, residence time for the Cache Slough, East Delta, and South Delta sub-regions are projected to increase by 25, 14, and 6 days, respectively, compared to the No Action Alternative. During the fall period, residence time in these sub-regions is projected to decrease slightly. Water residence time in Suisun Marsh is projected to decrease 21 days in the summer and increase 20 days in the fall, relative to No Action Alternative.

The summer and fall period average residence times provide a general direction in which residence time may change under Alternative 1A compared to the No Action Alternative. The changes in residence time are driven by a number of factors accounted for in the modeling, including the hydrodynamic effects of restoration actions planned under CM2 and CM4, diversion of Sacramento River water at the proposed north Delta intake facility, as well as changes in net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under Alternative 1A. However, the expected residence time changes under Alternative 1A, compared to the No Action Alternative, are in a direction and of magnitude that could lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs are discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley discussed in Appendix 5A Section D indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9–4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under Alternative 1A, relative to Existing Conditions, but these impacts are due entirely to climate change and not the project alternative. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under Alternative 1A, relative to the No Action Alternative.

SWP/CVP Export Service Areas

The assessment of effects from *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under Alternative 1A, exports from Banks and Jones pumping plants will consist of a mixture of Sacramento River water diverted around the Delta, with water quality characteristic of both upstream Sacramento River water, and Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water diverted from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the *Delta* Section above. Therefore, relative to Existing Conditions and the No

Action Alternative, the addition of Sacramento River water from the North Delta under Alternative 1A serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether Alternative 1A will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under Alternative 1A may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under Alternative 1A, relative to Existing Conditions. Conditions in the Export Service Areas under Alternative 1A are not expected to become more conducive to *Microcystis* bloom formation, relative to the No Action Alternative, because neither water residence time nor water temperatures will increase in the Export Service Areas.

NEPA Effects: In summary, Alternative 1A operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 1A operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 1A, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 1A will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 1A additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 1A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 1A, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 1A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 1A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 1A, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 1A. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 1A, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 1A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

It remains to be determined whether, or to what degree, *Microcystis* production will increase in Delta areas as a result of increased residence times associated with the implementation of the project alternative. Mitigation actions shall be focused on those incremental effects attributable to implementation of operations under the project alternative only. Development of mitigation actions for the incremental increase in *Microcystis* effects attributable to water temperature and residence time increases driven by climate change and sea level rise is not required because these changed conditions would occur with or without implementation of the project alternative. The goal of specific actions would be to reduce/avoid additional degradation of Delta water quality conditions with respect to occurrences of *Microcystis* blooms.

Additional evaluation will be conducted as part of the development of tidal habitat restoration areas to determine the feasibility of using site placement and design criteria to reduce or eliminate local conditions conducive to *Microcystis* production. Design criteria would be developed to provide guidelines for developing restoration areas to discourage *Microcystis* growth by maintaining adequate flushing, while maintaining the benefits of habitat restoration in terms of zooplankton production, fish food quality, and fish feeding success. For example, a target range of typical summer/fall hydraulic residence time that is long enough to promote phytoplankton growth, but not so long as to promote growth of *Microcystis*, could be used to aid restoration site design. However, currently there is not sufficient scientific certainty to evaluate whether or not longer residence times would result in greater *Microcystis* production, and also whether longer residence times might produce greater benefits to fish and other aquatic life than shorter residence times. This mitigation measure requires that residence time considerations be incorporated into restoration area site design for CM2 and CM4 using best available science at the time of design. It is possible that through these efforts, increases in *Microcystis* attributable to the project alternative, relative to Existing Conditions, could be mitigated. However, there may be instances where this design consideration may not be feasible, and thus, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Because it is not known where, when, and to what extent *Microcystis* will be more abundant under CM1 than under Existing Conditions, specific mitigation measures cannot be described. However, this mitigation measure requires the project proponents to monitor for *Microcystis* abundance in the Delta and use appropriate statistical methods to determine whether increases in abundance are significant. This mitigation measure also requires that if *Microcystis* abundance increases, relative to Existing Conditions, the project proponents will investigate and evaluate measures that could be taken to reduce residence time in the affected areas of the Delta. Operational actions could include timing of temporary or operable barrier openings and closings, reservoir releases, and location of Delta exports (i.e., North Delta vs. South Delta pumping facilities). Depending on the location and severity of the increases, one or more of these actions may be feasible for reducing residence times. If so, these actions could mitigate increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions. However, it is possible that these actions would not be feasible because they would conflict with other project commitments, would cause their own environmental impacts, or would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Impact WQ-33: Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

Implementation of CM3 and CM6–CM21 is unlikely to affect *Microcystis* abundance in the rivers and reservoirs upstream of the Delta, in the Delta region, or the waters exported to the CVP and SWP service areas. Implementation of CM5, Seasonally Inundated Floodplain Restoration, could result in increased local water temperatures in areas near restored seasonally inundated floodplains. However, floodplain inundation typically occurs during spring and winter months when *Microcystis* growth is limited in general by low water temperatures and by insufficient surface water irradiance, and water temperatures would not increase sufficiently due to floodplain inundation such that effects on *Microcystis* growth would occur. Therefore, implementation of CM5 is unlikely to affect *Microcystis* blooms in the project area. Implementation of CM13, Invasive Aquatic Vegetation Control, may increase turbidity and flow velocity, particularly in restored aquatic habitats, which could discourage *Microcystis* growth in these areas. To the extent that IAV removal would affect turbidity and water velocity, it is possible that IAV removal could, to some degree, help offset the increase in *Microcystis* production expected under Alternative 1A, relative to the No Action Alternative.

As discussed in detail in Impact WQ-32, development of restoration areas which will occur under CM2 and CM4 could possibly increase the frequency, magnitude, and geographic extent of *Microcystis* blooms due to the hydrodynamic impacts that are expected to increase water residence times throughout various areas of the Delta relative to Existing Conditions and the No Action Alternative. Additionally, restoration activities that create shallow backwater areas, due to implementation of CM2 and CM4, could result in local warmer water that may encourage *Microcystis* growth during the summer bloom forming season and result in further degradation of water quality. Mitigation to specifically address the effects of local increases in water temperatures on *Microcystis* in the vicinity of such restoration areas is not available. Regardless of elevated water temperatures, sufficient residence time is required for *Microcystis* bloom formation. Thus, the combined effect on *Microcystis* from increased local water temperatures and increased water residence times may be reduced by implementation of Mitigation Measure WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain.

NEPA Effects: Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be adverse.

CEQA Conclusions: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 1A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 1A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely affect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural supply AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 1A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 1A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 31%, relative to Existing Conditions, and increase by 1%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1); thus there would be little to no degradation of water quality with regard to total nitrogen. The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 1A would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 1A is estimated to decrease by 2% relative to Existing Conditions and 7% relative to the No Action Alternative (Appendix 8O, Table O-1); thus there would be no degradation of water quality with regard to total phosphorus. The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to nutrients.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 1A. Mercury load to the Bay, is estimated to be the same relative to Existing Conditions, and to decrease by 3 kg/year (1%) relative to the No Action Alternative. Methylmercury load is estimated to decrease by 0.04 kg/year (1%), relative to Existing Conditions, and by 0.13 kg/year (4%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 260 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 1A, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 4% relative to Existing Conditions; relative to the No Action Alternative there would essentially be no change in load (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 1A, the long-term average total selenium concentration of the North Bay is estimated to be 0.13 μg/L and the dissolved selenium concentration is estimated to be 0.11 μg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved water column selenium concentration would be below the target of 0.202 μg/L developed by Presser and Luoma (2013) to correspond to a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 μg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 1A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 1A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions; therefore, no substantial changes these constituents' levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31% decrease in total nitrogen load and 2% decrease in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated no change in mercury load (0 kg/year; 0%) and decrease in methylmercury load (0.04 kg/year; 1%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 4%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.3 Alternative 1B—Dual Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1B would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the east side of the Delta instead of through pipelines/tunnels. Intakes 1 through 5 would be located on the east bank of the Sacramento River. An intermediate pumping plant north of the town of Holt would be constructed as well as a new 600-acre Byron Tract Forebay. Unlike Alternative 1A, there would be no intermediate forebay. Culvert and tunnel siphons would be utilized to divert canal water beneath existing water courses. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.3, for additional details on Alternative 1B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1B has the same diversion and conveyance operations as Alternative 1A. The primary difference between the two alternatives is that conveyance under Alternative 1B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 1B has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The primary difference between Alternative 1B and Alternative 1A is that under Alternative 1B, a canal would be constructed for CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than a tunnel as the primary conveyance feature. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives*, Section 3.5.3). Consequently, Alternative 1B would involve substantial land surface construction disturbance. Construction of the canal conveyance facilities also would involve vegetation grubbing/removal, grading, excavation, soil stockpiling, levee and siphon construction, trenching, temporary access road construction, and soil hauling and storage, and other activities over approximately 21,500 acres during the course of constructing the facilities. Additionally, numerous natural drainages and constructed ditches would be rerouted to pass over, under, or around the canal, thus involving disturbance and potential work in flowing water. The remainder of the facilities constructed under Alternative 1B, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

***NEPA Effects*:** The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 1B would be similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with the construction of a canal, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 1B would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1B would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to the No Action Alternative, Alternative 1B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 1B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.4 Alternative 1C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

Alternative 1C would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal/tunnel along the west side of the Delta instead of through pipelines/tunnels. Intakes 1 through 5 would be located on the west bank of the Sacramento River and diverted water would be carried by canals and tunnels to a new 600-acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Culvert and tunnel siphons would be utilized to divert canal water beneath existing water courses. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.4, for additional details on Alternative 1C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1C has the same diversion and conveyance operations as Alternative 1A. The primary differences between the two alternatives are that conveyance under Alternative 1C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 1C has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The primary difference between Alternative 1C and Alternative 1A is that under Alternative 1C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to similar but shorter tunnel/pipeline features. Construction of water conveyance facilities would involve vegetation removal; constructing building pads, levees, canals, and a tunnel; excavation; overexcavation for facility foundations; surface grading; trenching; road construction; spoil storage; soil stockpiling; and other activities over approximately 17,400 acres during the course of constructing the facilities. Excavation of a large volume of borrow material would be required to construct the canals. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives*, Section 3.5.4). The remainder of the facilities constructed under Alternative 1C, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

***NEPA Effects*:** The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 1C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. However, given the addition of extensive canal conveyance segments under CM1 in addition to the tunnel/pipeline features, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 1C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1C would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of Alternatives,* and Appendix 3B for additional information regarding the environmental commitments and environmental permits). However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to No Action Alternative conditions, Alternative 1C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 1C for construction-related activities, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.5 Alternative 2A—Dual Conveyance with Pipeline/Tunnel and Five Intakes (15,000 cfs; Operational Scenario B)

Alternative 2A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove i.e., (Intakes 1 through 5). A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. In addition to the same physical/structural components described for Alternative 1A, Alternative 2A would include an operable barrier at the head of Old River and could potentially include two alternative intake and intake pumping plant locations located downstream of Steamboat and Sutter Sloughs (i.e., Intakes 6 and 7). Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.5, for additional details on Alternative 2A.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 2A, over the long term, average annual delta exports are anticipated to decrease by 76 TAF relative to Existing Conditions, and increase by 628 TAF relative to the No Action Alternative. Since, over the long-term, approximately 58% of the exported water will be from the new North Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 2–Old River at Rock Slough for ALL years (1976–1991), which shows increased SJR percentage and decreased SAC percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 2A, long-term average annual Delta outflow is anticipated to increase 105 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The increase relative to Existing Conditions is partially because Alternative 2A includes operations to meet Fall X2, while Existing Conditions does not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 2A by 645 TAF relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion (represented by an increase in BAY percentage) can be seen, for example, in Appendix 8D, ALT 2A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment upstream of the

Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of the effects of ammonia under Alternative 2A is the same as discussed under Alternative 1A, Impact WQ-1, except that because flows in the Sacramento River at Freeport would be different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-65 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 2A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November, and January through March, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 2A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 2A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 2A, relative to the No Action Alternative, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-65. Estimated Ammonia-N (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 2A

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 2A	0.073	0.088	0.069	0.061	0.058	0.061	0.058	0.062	0.062	0.063	0.071	0.065	0.066

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 2A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations would be expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps would not be expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 2A, relative to the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 2A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 2A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on ammonia under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 2A in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands), and would be similar compared to the No Action Alternative considering only changes due to Alternative 2A operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 2A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Effects of CM1 on boron under Alternative 2A in the Delta would be very similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative,

Alternative 2A would generally result in unchanged or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations. However, the average boron concentration at the eastern SJR at Buckley Cove location would increase relative to Existing Conditions (8%) but decrease relative to the No Action Alternative. Concentrations would increase at interior and western Delta locations (by as much as 3% at the SF Mokelumne River at Staten Island, 18% at Franks Tract, and 118% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-8). The comparison to Existing Conditions reflects changes due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3, *Plan Area*,), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 11% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) and up to 12% at the SJR at Buckley Cove location relative to No Action Alternative, would occur with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-9). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 2A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 2A in the Delta would be very similar to the effects discussed for Alternative 1A. Under Alternative 2A, long-term average boron concentrations would decrease by as much as 25% at the Banks Pumping Plant and by as much as 27% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-8) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 2A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 2A would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 2A would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 2A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 2A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 2A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on boron under Alternative 2A would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 2A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 2A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 2A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions, and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 2A, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Under Alternative 2A, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3, *Plan Area*,), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton (during the drought period only), and Barker Slough, while modeled long-term average bromide concentrations would decrease at all other assessment locations (Appendix 8E, *Bromide*, Table 6). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 63 μg/L (22% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 94 μg/L (75% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 2A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 2A, and would increase from 0% to 38% during the drought period. Relative increases in long-term average bromide concentrations at Staten Island would be of similar magnitude to that described for Barker Slough, although modeled 100 μg/L exceedance frequency increases would be much less considerable. At Staten Island, the predicted 100 μg/L exceedance frequency would increase from 1% under Existing Conditions to 4% under Alternative 2A (0% to 2% during the drought period). Modeled long-term average concentration at Staten Island would be about 62 μg/L (about 63 μg/L in drought years). Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. The comparison to Existing Conditions reflects changes in bromide due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 6). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 26% (about 75% in drought years) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove under Alternative 2A would increase relative to the No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects bromide changes due only to operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 6). Such similarity demonstrates that the modeled Alternative 2A change in bromide is almost entirely due to Alternative 2A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 2A is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*,) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 7). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 10% exceedance over the modeled period under Alternative 2A, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 20% under Alternative 2A. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the

North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 2A would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 165 µg/L (61% increase) at City of Antioch and would increase from 150 µg/L to 211 µg/L (41% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3, *Plan Area*,), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 2A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 46% relative to Existing

Conditions and 39% relative to the No Action Alternative. Relative change in long-term average bromide concentration would be less during drought conditions (≤34%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 6). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

NEPA Effects: The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*,) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 7).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 2A would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, Alternative 2A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 2A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 2A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative

2A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 2A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 2A would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 2A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 46% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 2A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 2A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 2A operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 22%, and 75% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 17% under Alternative 2A, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 2A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of up to about 3%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). The increased chloride concentrations would not increase the frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 2A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling predicts that Alternative 2A would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most assessment locations, and, depending on modeling approach (see Section 8.3.1.3, *Plan Area*), and would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤23%) and SF Mokelumne at Staten Island (i.e., ≤18%) (Appendix 8G, *Chloride*, Tables Cl-13 and Cl-14). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3, *Plan Area*. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 2A would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations and increased concentrations at the SF Mokelumne River at Staten Island (up to 26%), San Joaquin River at Buckley Cove (up to 3%), and the North Bay Aqueduct at Barker Slough (up to 21%) (Appendix 8G, Table Cl-13). The comparison to the No Action Alternative reflects chloride changes due only to operations.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 2A, the modeled frequency of objective exceedance would approximately double from 7% of years under Existing Conditions, to 13% of years under Alternative 2A (Appendix 8G, Table Cl-64). The increase was due to a single year, 1990, which was only one day short of the required number of days <150 mg/L. Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective. (See Section 8.3.1.1, *Models Used and Their Linkages*, for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP.)

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 2A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 2A (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride*, Table Cl-15). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 70%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 88%) (Appendix 8G, Table Cl-15), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 54% of available assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-17).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-16 and Cl-18). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of the 250 mg/L Bay Delta WQCP objective for chloride, and the magnitude of associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water of acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3) and Mallard Island (Appendix 8G, Figure Cl-1), and would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-4). Although modeling of Alternative 2A assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 2A, the modeled frequency of objective exceedance would increase from 0% under the No Action Alternative to 13% of years under Alternative 2A (Appendix 8G, Table Cl-64). The increase was due to two years, 1977 and 1990, which were only eight and one day(s) short of the required number of days <150 mg/L, respectively. Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1, *Models Used and Their Linkages*, for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. For Alternative 2A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 2A (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency would be predicted to decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 70%), decrease slightly at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 12%), and increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to 88%) (Appendix 8G, Table Cl-15). The available assimilative capacity would be reduced at the Antioch location compared to the No Action Alternative (i.e., reduction of 25% in April, and 100% in April [i.e., eliminated] during the drought period modeled) (Appendix 8G, Table Cl-17). Available assimilative capacity also would be reduced at the Contra Costa Canal at Pumping Plant #1 by up to 17% and 12% in September and October of the 16-year modeled period, respectively, and up to 100% in the drought period) (Appendix 8G, Table Cl-17), reflecting substantial degradation at these locations during months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-16 and Table Cl 18). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional seasonal and annual exceedances of the 250 mg/L objective as well as the magnitude of long-term average water quality degradation with respect to chloride at interior and western Delta locations, the potential exists for substantial adverse effects to the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride for Tom Paine Slough, Alternative 2A would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2).

Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3, and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Sensitivity analyses suggested that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 2A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 33% relative to Existing Conditions and 29% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-13). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to the Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-15). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-14 and Table Cl-16).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 2A is not expected to result in substantially increased frequency of exceedance of the 150 mg/L municipal and industrial objective at Contra Costa Pumping Plant #1 and Antioch locations. The frequency of exceedances of the 250 mg/L municipal and industrial objective at interior and western Delta locations would generally decrease, however, further water quality degradation would occur. Measureable water quality degradation also could occur relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 2A would contribute substantially to the adverse water quality effects.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this

constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 2A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 2A is not expected to result in substantially increased frequency of exceedance of the 150 mg/L municipal and industrial objective at Contra Costa Pumping Plant #1 and Antioch locations. Modeling results indicated that the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (by 3% each), but these frequencies are expected to be within the uncertainty present in the chloride modeling procedure. However, long-term degradation may occur that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 2A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Under Alternative 2A, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions. In summary, based on the discussion above, the effects on chloride from implementing CM2–CM21 are considered to be not adverse.

***CEQA Conclusion*:** Implementation of the CM2–CM21 for Alternative 2A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area compared to Existing Conditions. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on DO under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on DO under Alternative 2A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Reservoir storage reductions that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 2A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on DO under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 2A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 2A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling indicates that Alternative 2A would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point (fish and wildlife objective), and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity,* Table EC-2).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 26% under Alternative 2A, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 40% under Alternative 2A.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 5% under Alternative 2A, and the percentage of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 8% under Alternative 2A. Sensitivity analyses were performed for Alternative 4 Scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percentage of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 25% under Alternative 2A, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 29% under Alternative 2A. At Jersey Point, relative to the fish and wildlife objective, the percentage of days the EC objective would be exceeded for the entire period modeled would increase from 0% under Existing Conditions to 1% under Alternative 2A, and the percentage of days out of compliance with the EC objective would increase from 0% under Existing Conditions to 2% under Alternative 2A. Sensitivity analyses conducted for Alternative 4 Scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

The increase in percentage of days exceeding the EC objectives and days out of compliance at the Old River locations would be 2% at Tracy Bridge and less than 1% at Middle River. Sensitivity analyses performed for Alternative 4 Scenario H3 indicated that many of these exceedances are modeling artifacts, and modeling barrier installation assumptions consistent with historical dry year practices of installing barriers earlier in the year could resolve these additional exceedances (see Appendix 8H, Attachment 1, for a discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Furthermore, as noted in Section 8.1.3.7, *Salinity and Electrical Conductivity*, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations would decrease from 0–37% for the entire period modeled. During the drought period modeled (1987–1991), average EC would decrease by 0–32%, at western and southern Delta locations, except Emmaton would have an increase in average EC of 9% (Appendix 8H, Table EC-13). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at San Andreas Landing from February through September. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 15–16% for the entire period modeled (Appendix 8H, Table EC-13). The comparison to Existing Conditions reflects changes in EC due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-2). The increase in percentage of days exceeding the EC objective would be 24% at Prisoners Point and 12% or less at the remaining locations. The increase in percentage of days out of compliance would be 28% at Prisoners Point and 15% or less at the remaining locations. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point. The average EC increase would be 6% or less (Appendix 8H, Table EC-13). Similarly, during the drought period modeled, average EC would increase at all locations, except Emmaton and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (10%); the increase at the other locations would be 1–7% (Appendix 8H, Table EC-13). The comparison to the No Action Alternative reflects changes in EC due only to Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC would increase for the entire period modeled under Alternative 2A, relative to Existing Conditions, during the months of March through May by 0.3–0.6 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon's Landing, with long-term average EC levels increasing by 1.6–4.6 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.5–2.4 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 2A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

Given that the western and southern Delta are Clean Water Act Section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 2A, relative to Existing Conditions and the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 2A would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 2A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A would decrease 28% for the entire period modeled and 22% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 22% for the entire period modeled and 17% during the drought period modeled. (Appendix 8H, Table EC-13)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A would decrease 28% for the entire period modeled and 23% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 24% for the entire period modeled and 20% during the drought period modeled. (Appendix 8H, Table EC-13)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 2A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 2A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 2A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under Alternative 2A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels between

Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA Section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is Section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 2A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 2A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 20% increase), in the San Joaquin River at Prisoners Point (fish and wildlife objective; 19% increase), in the interior Delta. Average EC levels at San Andreas Landing would increase by 1% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act Section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in in the western Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 2A could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act Section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on EC under Alternative 2A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, *Mercury*, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 2A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 2A.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 2A relative to the 25 ng/L ecological risk benchmark showed the greatest decrease to be 2.2% for Old River at Rock Slough as compared to Existing Conditions, and 2.1% for Old River at Rock Slough as compared to the No Action Alternative (Figures 8-53a and 8-54a). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase in exceedance quotients was 13% at Old River at Rock Slough relative to Existing Conditions, and 11 - 12% at the Mokelumne River (South Fork) at Staten Island, Franks Tract, and Old River at Rock Slough relative to the No Action Alternative (Figure 8-55a and 8-55b; Appendix 8I, Table I-9b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 2A are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-2 and I-3). Therefore, mercury shows increased assimilative capacity at these locations (Figures 8-53a and 8-54a).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 2A, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 14% improvement relative to Existing Conditions, 17% relative to the No Action Alternative) (Figure 8-55a and 8-55b; Appendix 8I, Table I-9b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 2A to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 2A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 2A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 2A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 2A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Some habitat restoration activities under Alternative 2A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 2A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 2A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3, *Plan Area*) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 2A.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. In summary, because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in waterborne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 2A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 2A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 2A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 10 and 11). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 2A, relative to Existing Conditions, and slightly increased relative to the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 6.4% use of the assimilative capacity that was available under the No Action Alternative, for the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 12).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Regional Water Quality Control Board 2010a:32).
- Under Alternative 2A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 2A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification upgrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 2A, the increase is expected to be greater under Existing Conditions than for Alternative 2A due to the upgrades that are assumed under Alternative 2A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Table 10 and 11). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, *Nitrate*, Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Appendix 8J, *Nitrate*, Table 12).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on nitrate under Alternative 2A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 2A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Under Alternative 2A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.3–0.4 mg/L would be predicted (≤12% net increase) (Appendix 8K, *Organic Carbon*, DOC Table 3). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 74% under the Alternative 2A (an increase from 47% to 70% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 36% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 80% under Alternative 2A (45% to 80% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 41% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 2A would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other components of Operational Scenario B) and climate change/sea level rise.

In comparison, Alternative 2A relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.2–0.3 mg/L DOC (i.e., ≤9%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon*, DOC Table 3). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase slightly from 27% to 28% (42% to 50% for the modeled drought period). While the Alternative 2A would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 2A operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 2A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 2A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 2A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.5 mg/L (0.2 mg/L during drought period) (Appendix 8K, *Organic Carbon*, DOC Table 3). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Predicted decreases under relative to the No Action Alternative would be of similar magnitude. Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to 84% under Alternative 2A, while at the Jones pumping plant, exceedance frequency would increase from 72% to 88%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks and Jones. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 2A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects**:** In summary, Alternative 2A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.6 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.3 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 2A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 2A would result in relatively small increases (i.e., ≤12%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 2A would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 2A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 0.5 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted during periods of drought. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 2A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.4 mg/L at any single Delta assessment location (i.e., ≤12% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 2A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion**:** Effects of CM4–7 and CM10 on DOC under Alternative 2A would be similar to those discussed for Alternative 1A. This impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on pathogens under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Effects of CM1 on pathogens under Alternative 2A would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on pathogens under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 2A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 2A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito, and the San Joaquin River at Vernalis would change. Relative to Existing Conditions and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 2% during the summer and winter, while on the American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP, and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 2A, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 2A modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, *Source Water Fingerprinting Results*). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase 15% in August. At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13–17% during October through November and February through April. At Rock Slough, San Joaquin River source water fractions would increase 11–24% during September through March (11–15% during October and November of the modeled drought period). Similarly, San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 10–24% during October through April (11–13% during October and November of the modeled drought period). While the modeled 24% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤30%. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 13% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than

8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenario of Alternative 2A, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 16% in July (33% for the modeled drought period) and 25% in August (48% for the modeled drought period) (Appendix 8D, *Source Water Fingerprinting Results*). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 2A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 23–50% for the period of January through June (22–25% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 34–59% for the period of January through June (16–51% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 2A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 2A, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 2A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 2A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2–CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion: Effects of CM2–CM21 on pesticides under Alternative 2A are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 2A, which are considered to be not adverse. Based on this finding, this impact is considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 2A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 2A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 2A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 2A, which are considered to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 2A, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-12 and M-22 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 2A would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.04 μg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (4% or less) in available assimilative capacity for selenium, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 2A (range 0.09–0.40 μg/L) would be similar to those for Existing Conditions (range 0.09–0.41 μg/L) and the No Action Alternative (range 0.09–0.38 μg/L), and all would be below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-22). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 19% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.6 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 11% in all years (from about 4.4 to 4.9 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 4% to 8% at those locations. Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would be 1.5 (indicating a higher probability for adverse effects) for drought years at both locations (similar to Existing Conditions and the No Action Alternative and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on “fixed” K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 2A would be greater in the East Delta and South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 2A in the East Delta are expected to increase by more than 16 days (Table 8-60a). Relative to the No Action Alternative, annual average residence times for Alternative 2A in the East Delta are expected to increase by less than 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and of CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 would be substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the waterborne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold

(73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean Kd (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher Kd values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions, and 3 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in essentially no change in selenium concentrations throughout the Delta for most biota (approximately 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 2A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 2A would result in small (0.06–0.09 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 6–9%, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, the long-term average selenium concentrations in water for Alternative 2A (range 0.15–0.19 μg/L) would be well below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-22) at Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative 2A (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 2A are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010d] and State Water Board [2010b, 2010c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 2A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.1 for Alternative 2A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 2A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 2A would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 2A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This alternative is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 2A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 2A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 2A, relative to Existing Conditions and the No Action Alternative. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***NEPA Effects*:** In summary, Alternative 2A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 2A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 2A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 2A.

The assessment of the Alternative 2A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 2A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 2A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 2A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 2A would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion: Effects of CM1 on TSS and turbidity under Alternative 2A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 2A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on TSS and turbidity under Alternative 2A would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The conveyance features for CM1 under Alternative 2A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 2A and Alternative 1A is that under

Alternative 2A, the locations of two intakes and two intermediate pumping plant locations would differ. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 2A, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types and magnitude of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2A would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*. The specific environmental commitments that would be implemented under Alternative 2A would be similar to those described for Alternative 1A. Consequently, relative to the No Action Alternative, Alternative 2A would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 2A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 2A, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 2A compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 2A, relative to Existing

Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 2A, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 2A may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 2A would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 2A operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 2A operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 2A, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 2A will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 2A, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 2A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 2A, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 2A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 2A, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 2A. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 2A, relative to Existing Conditions, would result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 2A would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measure WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 2A would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 2A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 2A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely affect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 2A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 2A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 26%, relative to Existing Conditions, and increase by 9%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 2A would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 2A is estimated to increase slightly (by 1%) relative to Existing Conditions and decrease by 4% relative to the No Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 2A. Mercury load to the Bay, is estimated to be the same relative to Existing Conditions, and to decrease by 2 kg/year (1%) relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.07 kg/year (2%), relative to Existing Conditions, and decrease by 0.02 kg/year (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 261 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San Francisco Bay due to Alternative 2A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 2A are projected to cause the total selenium load to the North Bay to increase by 8%, relative to Existing Conditions, and 5%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 2A, the long-term average total selenium concentration of the North Bay is estimated to be 0.14 µg/L and the dissolved selenium concentration is estimated to be 0.12 µg/L, which would be a 0.01 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 2A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 2A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 2A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions; therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 26% decrease in total nitrogen load and 1% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated no change in mercury load (0 kg/year; 0%) and increase in methylmercury load (0.07 kg/year; 2%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 8%, but estimated total and dissolved selenium concentrations under this alternative would be nearly the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.6 Alternative 2B—Dual Conveyance with East Alignment and Five Intakes (15,000 cfs; Operational Scenario B)

Alternative 2B would include the same physical/structural water conveyance components and eastern alignment as Alternative 1B, but, like Alternative 2A, could entail two different intake and intake pumping plant locations downstream of Steamboat and Sutter Slough (i.e., Intakes 6 and 7). Alternative 2B would also include an operable barrier at the head of Old River. Intakes would be located on the west bank of the Sacramento River and diverted water would be carried by canal to a new 600-acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.6, for additional details on Alternative 2B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2B has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary difference between the two alternatives is that conveyance under Alternative 2B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 2B has the same conservation measures as Alternative 2A Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under

Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The primary difference between Alternative 2B and Alternative 1A is that under Alternative 2B, a canal would be constructed for CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.6). The remainder of the facilities constructed under Alternative 2B, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2B would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. However, given the substantial differences in the conveyance features under CM1 with construction of a canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2B would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2B would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for tunnel muck dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to the No Action Alternative, Alternative 2B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 2B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.7 Alternative 2C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario B)

Alternative 2C would include the same physical/structural water conveyance components and western alignment as Alternative 1C, but would also include an operable barrier at the head of Old River. Intake 1 through 5 would be located on the west bank of the Sacramento River and diverted water would be carried by canals and tunnels to a new 600-acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.7, for additional details on Alternative 2C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2C has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary differences between the two alternatives is that conveyance under Alternative 2C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 2C has the same conservation measures as Alternative 2A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The primary difference between Alternative 2C and Alternative 1A is that under Alternative 2C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.7). The remainder of the facilities constructed under Alternative 2C, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

***NEPA Effects*:** The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of a canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to the No Action Alternative, Alternative 2C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 2C for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.8 Alternative 3—Dual Conveyance with Pipeline/Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

Alternative 3 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 3 would convey up to 6,000 cfs of water from the north Delta to the south Delta. Diverted water would be conveyed through pipelines/tunnels from two screened intakes (i.e., Intakes 1 and 2) located on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 3 would include a 750-acre intermediate forebay and pumping plant. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include Fall X2. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.8, for additional details on Alternative 3.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Since the only difference between Alternative 3 and Alternative 1A is that the north Delta diversion capacity under Alternative 3 is 6,000 cfs instead of 15,000 cfs under Alternative 1A, effects on Delta hydrodynamics under Alternative 3 are very similar to Alternative 1A, but are generally of a lesser extent.

Under Alternative 3, over the long term, average annual delta exports are anticipated to increase by 227 TAF relative to Existing Conditions, and decrease by 930 TAF relative to the No Action Alternative. Since, over the long-term, approximately 35% of the exported water will be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 3–Old River at Rock Slough for ALL years (1976–1991), which shows increased SJR percentage and decreased SAC percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 3, long-term average annual Delta outflow is anticipated to decrease 227 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is increased sea water intrusion in the west Delta. The increase of sea water intrusion in the west Delta under Alternative 1A is greater relative to the No Action alternative because the No Action alternative includes operations to meet Fall X2, whereas Existing Conditions and Alternative 3 do not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 3 by 977 TAF relative to the No Action Alternative, due only to changes in operations. The increases in sea water intrusion (represented by an increase in BAY percentage) can be seen, for example, in Appendix 8D, ALT 3–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 3 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-66 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 3 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during February, August, September, and November, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 3, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 3 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 3, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-66. Estimated Ammonia-N (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 3

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 3	0.068	0.089	0.068	0.060	0.058	0.060	0.058	0.062	0.064	0.064	0.073	0.076	0.067

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 3 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 3, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 3, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 3, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on ammonia under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 3 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 3 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 3 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Effects of CM1 on boron under Alternative 3 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 3 would result in unchanged or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, and would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 9% at Franks Tract, 6% at Old River at Rock Slough, and 4% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-10). This comparison to Existing Conditions reflects changes due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise. This comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative conditions (Appendix 8F, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-11). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 3, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 3 in the Delta would be very similar to the effects discussed for Alternative 1A. Under Alternative 3, long-term average boron concentrations would decrease by as much as 15% at the Banks Pumping Plant and by as much as 14% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-10) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 3 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 3 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 3 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations (i.e., up to 9% increase) in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 3 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to

Existing Conditions, Alternative 3 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 3 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on boron under Alternative 3 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 3 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 3 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 3 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 3, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3% relative to Existing Conditions and less than <1% relative to No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 3, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 3, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would generally decrease at other assessment locations (Appendix 8E, *Bromide*, Table 8). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 69 μg/L (34% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 99 μg/L (85% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease slightly from 49% under Existing Conditions to 48% under Alternative 3, but would increase from 55% to 77% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 22% under Alternative 3, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 μg/L bromide threshold exceedance increase from 47% under Existing Conditions to 71% under Alternative 3 (52% to 73% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 μg/L assessment threshold concentration 1% under Existing Conditions and 3% under Alternative 3(0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 60 μg/L (62 μg/L for the modeled drought period) at Staten Island under Alternative 3. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

In comparison, Alternative 3 relative to the No Action Alternative would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants (Appendix 8E, *Bromide*, Table 8). These increases would continue to be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 38% (about 85% in drought years) relative to the No Action Alternative. Increases in long-term average bromide concentrations would be less than 29% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in the frequency with which concentration thresholds of 50 μg/L and 100 μg/L are exceeded are of similar magnitude to the previously described existing condition comparison. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 3 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 8). Such similarity demonstrates that the modeled Alternative 3 change in bromide is almost entirely due to Alternative 3 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 3 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 9). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 3, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 18% under Alternative 3. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 3 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 149 µg/L (45% increase) at City of Antioch and would increase from 150 µg/L to 201 µg/L (34% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 3, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 31% relative to Existing Conditions and 21% relative to the No Action Alternative. Relative change in long-term average bromide concentration would generally be less for the drought period (≤31%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 8). As a result, less frequent bromide concentration exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

NEPA Effects: The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 9).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 3 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, Alternative 3 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 3 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 3 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 3 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 3, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 3 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 3, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 31% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 3 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 3, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 3 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34%, and 85% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 3, while for the modeled drought period, the frequency would increase from 0% to 47%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM21would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–

CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 3, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 3 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 3 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that Alternative 3 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤28%), SF Mokelumne at Staten Island (i.e., ≤19%), Sacramento River at Emmaton (i.e., ≤16%), and Sacramento River at Mallard Island (i.e., ≤5%) (Appendix 8G, *Chloride*, Table Cl-19 and Table Cl-20). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 3A would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations (Appendix 8G, Table Cl-19). The increases in long-term average chloride concentrations would generally be largest compared to the No Action Alternative condition, ranging from 2% at the San Joaquin River at Buckley Cove to 32% at the North Bay Aqueduct at Barker Slough. Long-term average chloride concentrations would decrease at the Banks pumping plant and Jones pumping plant locations. The comparison to the No Action Alternative reflects chloride changes due only to operations.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 3, the modeled frequency of objective exceedance would be unchanged at 7% of years under Existing Conditions and Alternative 3 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 3, the modeled frequency of objective exceedance would decrease slightly, from 6% of modeled days under Existing Conditions, to 4% of modeled days under Alternative 3 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would occur for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 74%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-21), and would cause further degradation at Antioch in March and April (Appendix 8G, Table Cl-23). The frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would not increase (Appendix 8G, Table Cl-21); however, available assimilative capacity would be reduced by up to 100% (i.e., eliminated) in October and November compared to Existing Conditions (Appendix 8G,

Table Cl-23), reflecting substantial degradation during these months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-22 and Table Cl-24). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of the 250 mg/L Bay Delta WQCP objectives for chloride, and the magnitude of associated long-term average water quality degradation at interior and western Delta locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3), Mallard Island (Appendix 8G, Figure Cl-1), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., up to a tripling of concentration in December through February) (Appendix 8G, Figure Cl-4). Although modeling of Alternative 3 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 3, the modeled frequency of objective exceedance would increase from 0% under the No Action Alternative to 7% of years under Alternative 3 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. For Alternative 3, the modeled frequency of objective exceedance would decrease slightly from 5% of modeled days under the No Action Alternative to 4% of modeled days under Alternative 3 (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small increase in exceedance frequency would be predicted relative to the No Action Alternative at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% for the No Action Alternative to 20%), San Joaquin River at Antioch (i.e., from 73% to 74%), and Sacramento River at Mallard Island (i.e., from 86% to 87%) (Appendix 8G, Table Cl-21). Additionally, the available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in September through November (i.e., ranging from 29% to 100% [i.e., elimination]) and at the Antioch location in April (i.e., up to 46%) (Appendix 8G, Table Cl-23), reflecting substantial degradation during these months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-22 and Table Cl-24). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP objectives for chloride, and the magnitude of associated long-term average water quality degradation at interior and western Delta locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride for Tom Paine Slough, Alternative 3 would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2).

Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3, and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions but sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 3, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 30% relative to Existing Conditions and 21% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-19). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-21). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-20 and Table Cl-22).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 3 would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and could contribute to measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 3 would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 3 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 3 would result in substantially increased chloride concentrations in the Delta such that the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 8%) and at Mallard Slough (by 2%), and long-term degradation may occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 3 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply, and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Under Alternative 3, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 3 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on DO under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 3, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on DO under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 3 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 3 in water bodies upstream of the

Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling indicates that Alternative 3 would result in an increase in the number of days when Bay-Delta WQCP compliance locations would exceed EC objectives or be out of compliance with the EC objectives at the Sacramento River at Emmaton and San Joaquin River at Jersey Point (fish and wildlife objective) in the western Delta and San Joaquin River at San Andreas Landing in the interior Delta (Appendix 8H, Table EC-3).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 30% under Alternative 3, and the days out of compliance with the EC objective would increase from 11% under Existing Conditions to 44% under Alternative 3.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 4% under Alternative 3. Further, the percentage of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 6% under Alternative 3. Sensitivity analyses were performed for Alternative 4 Scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

At Jersey Point, relative to the fish and wildlife objective, the percentage of days of EC objective exceedance and days out of compliance would increase from 0% under Existing Conditions to 3% under Alternative 3, which represents a very small increase for this objective. Further discussion of EC increases relative to this objective can be found in Appendix 8H, Attachment 2.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–28% for the entire period modeled and 2–30% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-14). At Emmaton, average EC would increase by 14% for the entire period modeled and 12% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire period modeled and 13% during the drought period modeled. On average, EC would increase at Emmaton during December and March through September. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 14–17% for the entire period modeled (Appendix 8H, Table EC-14; further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the western portion of the Delta at Emmaton would have an increased frequency of exceedance of EC objectives (Appendix 8H, Table EC-3) and increased average EC. Thus, Alternative 3 could contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. These EC changes are similar to that described for Alternative 1A. The comparison to Existing Conditions reflects changes in EC due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River; and Old River at Tracy Bridge (Appendix 8H, Table EC-3). The increase in percentage of days exceeding the EC objective would be 3% or less and the increase in percentage of days out of compliance would be 5% or less, with the exception of Emmaton, which would have a 16% increase in days exceeding the EC objective and a 19% increase in days out of compliance. Regarding exceedances at Old River at Middle River and at Tracy Bridge, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (13%), San Joaquin River at Jersey Point (2%), S. Fork Mokelumne River at Terminous (4%),San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-14). For the drought period modeled, the locations with an average EC increase, relative to the No Action Alternative, would be: Sacramento River at Emmaton (1%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (5%) (Appendix 8H, Table EC-14). The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased incidence of exceedance of EC objectives and EC degradation that could occur in the western Delta could make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. These EC changes are similar to that described for Alternative 1A. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 3, relative to Existing Conditions, during the months of March through May by 0.3–0.9 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon's Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23).

Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.7–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 3 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment. These EC changes are similar to that described for Alternative 1A.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 3 would result in no exceedances of the Bay-Delta WQCP’s 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under Alternative 3.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 3 would decrease 18% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 12% for the entire period modeled and drought period modeled. (Appendix 8H, Table EC-14)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 3 would decrease 17% for the entire period modeled and 20% during the drought period modeled.

Relative to the No Action Alternative, average EC levels would decrease by 13% for the entire period modeled and 16% during the drought period modeled. (Appendix 8H, Table EC-14)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 3 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 3 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 3 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under Alternative 3, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 3 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 3 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the Sacramento River at Emmaton (24%; western Delta) for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 14% for the entire period modeled and 12% during the drought period modeled. Average EC levels at San Andreas Landing would increase by 12% for the entire period modeled and 13% during the drought period modeled. In addition, there would be an increase in the average EC of 14–17% at Jersey Point (for the entire period modeled) during the months of April–May, when the fish and wildlife objective applies. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC; however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 3 could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on EC under Alternative 3 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 3, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 3 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore, mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 3.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 3 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.7% for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant, and 0.8% for the Mokelumne River (South Fork) at Staten Island and Franks Tract relative to the No Action Alternative (Figures 8-53a and 8-54a). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and the same as the No Action Alternative (Appendix 8I, Table I-6 and Figure I-3). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue showed small increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. There was a 6% increase at the Mokelumne River (South Fork) at Staten Island, the San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough relative to Existing Conditions, and a 8% increase at the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figures 8-55a, and 8-55b; Appendix 8I, Table I-10b). All water export locations except Contra Costa Pumping Plant #1 showed improved bass tissue mercury estimates (Figures 8-55a and 8-55b; Appendix 8I, Tables I-10a, I-10b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 3 are projected to be lower than Existing Conditions, and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-2 and I-3). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a). Bass tissue mercury concentrations are also improved under Alternative 3, relative to Existing Conditions and the No Action Alternative (Figures 8-55a and 8-55b; Appendix 8I, Tables I-10a, I-10b).

NEPA Effects: In summary, based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 3 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 3, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 3 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 3 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 3 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities under Alternative 3 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 3 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 3 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 3.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation.

In summary, because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in waterborne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 3 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 3, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 3.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 13 and 14). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 3, relative to Existing Conditions and would be nearly the same (i.e., any increase would be negligible) as that under the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except for Jones PP in November, where use of assimilative capacity available under Existing Conditions was 6.5% in the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 15).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Regional Water Quality Control Board 2010a:32).
- Under Alternative 3, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 3, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification upgrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 3, the increase is expected to be greater under Existing Conditions than for Alternative 3 due to the upgrades that are assumed under Alternative 3.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 3i, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate,* Tables 13 and 14). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, *Nitrate*, Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Appendix 8J, *Nitrate*, Table 15).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on nitrate under Alternative 3 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 3, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 3, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 3, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be less. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2–0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, *Organic Carbon*, DOC Table 4). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 65% under the Alternative 3 (an increase from 47% to 63% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 33% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 65% under Alternative 3 45% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 37% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 3 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other components of Operational Scenario A) and climate change/sea level rise.

In comparison, Alternative 3 relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.1–0.2 mg/L DOC (i.e., ≤7%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 4). Threshold concentration exceedance frequency trends would also be similar to those discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 63% for the modeled drought period). While the Alternative 3 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 3 operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 3 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 3 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 3, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period, relative to Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 4). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L (<0.1 mg/L during drought period). Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under Existing Conditions to 69% under Alternative 3 (57% to 92% for the drought period), and at Jones would increase from 71% to 77% (72% to 88% for the drought period). In contrast, however, the frequency of concentrations exceeding 4 mg/L at Banks and Jones would decrease or remain relatively unchanged. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP

Export Service Areas predict an overall long-term improvement in Export Service Areas water quality, primarily through a reduction in exports of water exceeding 4 mg/L.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 3 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 3, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.4 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.2 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 3 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 3 would result in relatively small increases (i.e., ≤8%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 3 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 3 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 0.3 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 3 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In addition to and to supplement Mitigation Measure WQ-18, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 3 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Effects of CM4–CM7 and CM10 on DOC under Alternative 3 would be similar to those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on pathogens under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on pathogens under Alternative 3 would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on pathogens under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 3, no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 3, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 7% during the summer and 2% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 14% during the summer, but would increase by as much as 18% in the winter. Similarly, American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 3, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–

1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 3 modeled San Joaquin River fractions would increase greater than 10% at (not including Banks and Jones, discussed below) Rock Slough and Contra Costa PP No. 1 (Appendix 8D, *Source Water Fingerprinting Results*). At Rock Slough, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 11% during March, while at Contra Costa PP No. 1 San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14% during March. Corresponding increases for the modeled drought period would not be greater than 7% at Rock Slough or Contra Costa PP No. 1. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 10% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 13% in July and 24% in August when compared to No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 3, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 12–34% for the period of January through June (12–22% for March through May of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 18–39% for the period of January through June (12–36% for February through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 3 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 3, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 3 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 3 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** CM2–CM21 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2–CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion**:** Effects of CM2–CM21 on pesticides under Alternative 3 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 3, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 3, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 3, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 3 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 3, which are considered to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the

Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 3, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-13 and M-23 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 3 would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01 μg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (1% or less) in available assimilative capacity for selenium, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 3 (range 0.09–0.38 μg/L) would be similar to those for Existing Conditions (range 0.09–0.41 μg/L) and the No Action Alternative (range 0.09–0.38 μg/L), and all would be below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-23). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 7% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 4$ in all years (from about 4.4 to 4.6 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2% or 3% at those locations (Appendix 8M, Tables M-30 and

M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative); however, for the entire period modeled, the quotient would not be exceeded at either location (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on “fixed” K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 3 would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 3 in the East Delta are expected to increase by more than 15 days (Table 8-60a). Relative to the No Action Alternative, annual average residence times for Alternative 3 in the East Delta are expected to increase by less than 9 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the waterborne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions, and 4 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 3 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 3 would result in small (0.04 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 4%, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, the modeled selenium concentrations in water for Alternative 3 (range 0.17–0.24 μg/L) would be below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-23) at Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative 3 (Figures 8-61a through 8-64b).

***NEPA Effects*:** Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 3 are not considered to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, Determination of Effects) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010d] and State Water Board [2010b, 2010c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 3 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.0 for Alternative 3. Concentrations of selenium in sturgeon would exceed only the lower benchmark during the drought period modeled, indicating a low potential for effects. Overall, Alternative 3 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance for sturgeon relative to the low benchmark for sturgeon during the drought period and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 3 would cause no increase in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 3 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment

(Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on selenium under Alternative 3 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 3 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 3, relative to Existing Conditions and the No Action Alternative. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 3, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 3 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 3.

The assessment of the Alternative 3 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 3 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** CM2–CM21 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 3, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 3 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on TSS and turbidity under Alternative 3 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 3, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 bon TSS and turbidity under Alternative 3 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

***NEPA Effects*:** The conveyance features for CM1 under Alternative 3 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 3 and Alternative 1A is that under Alternative 3, there would be three fewer intakes and three fewer pumping plants constructed, which would result reduce the level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 3, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of CM1 under Alternative 3 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 3 would be similar to those described for Alternative 1A. Consequently, relative to the No Action Alternative, Alternative 3 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 3 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 3, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 3 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 3, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 3, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 3 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 3 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 3 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 3 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 3, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 3 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 3, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 3 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 3, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 3. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 3, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 3. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 3, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21).

The effects of CM2–CM21 on *Microcystis* under Alternative 3 would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 3 would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 3 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 3 on bromide, chloride, and DOC in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely affect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 3 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 3 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 33%, relative to Existing Conditions, and decrease by 9%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 3 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 3 is estimated to decrease by 1%, relative to Existing Conditions and by 6% relative to the No Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 3. Mercury load to the Bay is estimated to decrease by 2 kg/year (1%), relative to Existing Conditions, and to decrease by 5 kg/year (2%), relative to the No Action Alternative. Methylmercury load is estimated to decrease by 0.04 kg/year (1%), relative to Existing Conditions, and by 0.13 kg/year (4%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 258 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San Francisco Bay due to Alternative 3 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 3, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 1%, relative to Existing Conditions, and decrease by 2%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 3, the long-term average total selenium concentration of the North Bay is estimated to be 0.13 µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 3 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 3, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 3 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions; therefore, no substantial changes these constituents' levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 33% decrease in total nitrogen load and 1% decrease in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated reduction in mercury load (2 kg/year; 1%) and methylmercury load (0.04 kg/year; 1%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 1%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Alternative 4 would comprise physical/structural components similar to those under Alternative 1A; however, there are notable differences. Alternative 4 would convey up to 9,000 cfs of water from the north Delta to the south Delta and that Alternative 4 would include an operable barrier at the head of Old River. Diverted water would be conveyed through pipelines/tunnels from three screened intakes (i.e., Intakes 2, 3, and 5) located on the east bank of the Sacramento River between Clarksburg and Courtland. Alternative 4 would include a 243-acre intermediate forebay at Glannvale Tract. Clifton Court Forebay would be dredged and expanded by approximately 690 acres to the southeast of the existing forebay. Water supply and conveyance operations would follow the guidelines described as Scenarios H1, H2, H3, or H4, which variously include or exclude implementation of Fall X2 and/or enhanced spring outflow. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.9, for additional details on Alternative 4.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.

- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 4, over the long term, average annual delta exports are anticipated to range from an increase of 112 TAF under Scenario H1 to a decrease by 730 TAF under Scenario H4 relative to Existing Conditions, and an increase by 815 TAF under Scenario H1 to a decrease of 27 TAF under Scenario H4 relative to the No Action Alternative. Because, over the long-term, between 47% (Scenario H1) and 49% (Scenario H4) of the exported water would be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this would be increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 4, H3–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 4, long-term average annual Delta outflow is anticipated to range from a decrease of 114 TAF under Scenario H1 to an increase 744 TAF under Scenario H4 relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs, Fall X2, and numerous other operational components of Scenarios H1 through H4) and climate change/sea level rise (see Chapter 5, Water Supply, for more information). Long-term average annual Delta outflow is anticipated to decrease under Alternative 4 by between 864 (Scenario H1) and 5 TAF (Scenario H4) relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 4, H3–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 (including the different operational components of Scenarios H1–H4) would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 4 than under Existing Conditions, and would be the same as would occur under the No Action Alternative. Relative to Existing Conditions, ammonia-N concentrations downstream of the SRWTP would be substantially lower under Alternative 4 (including the different operational components of Scenarios H1–H4) because it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia-N concentration would not exceed 1.5 mg/L-N in April through October or 2.4 mg/L-N in November through March. Consequently, a substantial decrease in Sacramento River ammonia-N concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Concentrations of ammonia-N at locations not influenced notably by Sacramento River water will change little relative to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 4 would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 4 as would occur under the No Action Alternative, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 4, relative to the No Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This change would be attributable only to operations of Alternative 4, since the same assumptions regarding water demands, climate change, and sea level rise are included in both Alternative 1A and the No Action Alternative.

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 4 and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Regional Water Quality Control Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia concentration (1.5 mg/L-N in Apr–Oct, 2.4 mg/L-N in Nov–Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-67 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-67 shows, average monthly ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under the four different operational scenarios of Alternative 4 and under the No Action Alternative are expected to be similar (Table 8-67). In comparison to the No Action Alternative, minor increases in monthly average ammonia-N concentrations would occur during February, July through September, and during November for all operational scenarios (H1 through H4). Under operational Scenario H2 and H4, minor increases in ammonia-N concentrations also would occur in the months of January and March. In the month of December, average ammonia-N concentrations would increase slightly for Scenario H4. Minor decreases in ammonia-N concentrations are expected for all Scenarios (H1 through H4) in May and June, while minor decreases would also occur in October under Scenario H1.

A minor increase in the annual average concentration would occur under the different operational components of Scenarios H1 through H4 of Alternative 4, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 4 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River.

Consequently, changes in source water fraction anticipated under Alternative 4, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-67. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 4 Operational Scenarios H1, H2, H3, and H4

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Scenario H1	0.073	0.090	0.068	0.060	0.058	0.060	0.058	0.063	0.062	0.062	0.070	0.076	0.067
Scenario H2	0.074	0.088	0.069	0.061	0.058	0.061	0.058	0.063	0.062	0.062	0.070	0.065	0.066
Scenario H3	0.074	0.090	0.069	0.060	0.058	0.060	0.057	0.062	0.066	0.064	0.071	0.075	0.067
Scenario H4	0.074	0.088	0.070	0.061	0.058	0.061	0.057	0.062	0.066	0.064	0.071	0.065	0.066

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D, *Source Water Fingerprinting Results*). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under the four different operational scenarios of Alternative 4, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this

constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 4 (regardless of operational scenario), relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged compared to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. In general, with the exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). Additionally, implementation of CM12–CM21 would not be expected to substantially alter ammonia concentrations in the affected environment.

The effects of ammonia from implementation of CM2–CM21 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4 Scenarios H1–H4, there would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in association with the different operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and would remain virtually the same relative to the No Action Alternative considering only changes due only to the different operational components of Scenarios H1–H4 under Alternative 4. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios (Appendix 8F, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 4 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3, *Plan Area*, for more information.

The effects relative to Existing Conditions and the No Action Alternative are discussed together because the direction and magnitude of predicted change are so similar. Relative to Existing Conditions, the following changes reflect the range of effects that would result from the four potential outcomes under the Alternative 4 H1–H4 Scenarios. There would be generally similar increased long-term average boron concentrations for the 16-year period modeled at interior Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island for all H1–H4 Scenarios, from 12% for H1 to 15% for H4 at Franks Tract, and from 11% for H1 to 18% for H4 at Old River at Rock Slough) (Appendix 8F, Tables Bo-12A through Bo-12D). The comparisons to Existing Conditions reflects changes due to the different operational components of Scenarios H1–H4 for Alternative 4 and climate change/sea level rise. Comparison to the No Action Alternative reflects changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3, *Plan Area*), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3B). Additionally, relative to the Existing Conditions, reductions in long-term average assimilative capacity would be small with respect to the 500 μg/L agricultural objective at interior Delta locations and reductions would be similar for all of the Alternative 4 H1–H4 Scenarios (i.e., range of maximum monthly reductions of 12% (H1) to 13% (H4) at Franks Tract and up to 13% (H1) to 18% (H4) at Old River at Rock Slough (Appendix 8F, Tables Bo-13A through 13D), and the reductions in assimilative capacity relative to the No Action Alternative also would be comparable. However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 4, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Under all of the Alternative 4 H1–H4 Scenarios, long-term average boron concentrations would decrease at the Banks Pumping Plant (ranging from as much as 21% [H1]) to a 9% [H2]) and at Jones Pumping Plant (ranging from 23% [H4] to 19% [H1]) relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (Appendix 8F, Tables Bo-12A through 12D) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 4 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 4 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 4 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response (i.e., up to 15% increase) to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 4 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 4 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 4 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM21), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4–CM10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12–CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12–CM21 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of CM2–CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment.

The impact on boron of implementing CM2–CM21 is determined to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 4 would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, the their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, regardless of operational scenario (i.e., Scenarios H1–H4), there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds.

Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 4 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, no individual operational scenario of Alternative 4 would be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These similar decreases in flow, regardless of operational scenario, would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small predicted increases in lower San Joaquin River bromide levels that could occur under Scenarios H1–H4 of Alternative 4, relative to existing and No Action Alternative conditions, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Under Operational Scenarios H1–H4 of Alternative 4, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to those previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Scenarios H1–H4 modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while Scenarios H1–H4 modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 10). Overall effects would be greatest at Barker Slough, with the smallest model predicted increases occurring under Scenario H3, and the largest model predicted increases occurring under Scenario H2. Under Scenario H3, predicted long-term average bromide concentrations would increase from 51 μg/L to 62 μg/L (21% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 92 μg/L (72% relative increase) for the modeled drought period. Under Scenario H2, predicted long-term average bromide concentrations would increase from 51 μg/L to 72 μg/L (40% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 106 μg/L (98% relative increase) for the modeled drought period. At Barker Slough, changes in exceedance frequency would follow a similar pattern, with the greatest increase in exceedance frequency occurring under Scenario H2. Under Scenario H2, the predicted 50 μg/L exceedance frequency would increase from 49% under Existing Conditions to 56% under Alternative 4, and would increase from 55% to 83% during the drought period. Similarly at Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to

20% under Scenario H2, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 76% under Scenario H2 (52% to 83% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 3% under all operational scenarios (0% to 2% during the modeled drought period for all operational scenarios). The highest long-term average bromide concentrations would occur under Scenario H2, and would be 76 µg/L (83 µg/L for the modeled drought period) at Staten Island. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial for all operational scenarios. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different components of Operational Scenarios H1–H4) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative would be generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 10). Relative to the No Action Alternative, modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough under Scenario H2, where long-term average concentrations are predicted to increase by 44% (97% for the modeled drought period). However, unlike the Existing Conditions comparison, under the No Action Alternative long-term average bromide concentrations at Buckley Cove would increase for all operational scenarios, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to the different components of Operational Scenarios H1–H4 of Alternative 4.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Tables 10 and 11). Such similarity demonstrates that the modeled Alternative 4 change in bromide is almost entirely due to Alternative 4 operations, and not climate change/sea level rise, regardless of the specific different components of Operational Scenarios H1–H4. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless of whether and particular operational scenario of Alternative 4 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 11). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. Under all of the operational scenarios, the increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Model predicted increases under Scenario H2 were still the greatest, and increases under the other operational scenarios were still substantial. At Barker Slough, the predicted 100 µg/L exceedance frequency for the 16-year hydrologic period would increase from 1% under Existing Conditions and 2% under the No Action Alternative to as much as 11% under the Scenario H2. For the modeled drought period, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions and the No Action Alternative to as much as 25% under Scenario H2. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

Although Scenario H2 would result in the greatest relative increase in long-term average bromide concentrations and greatest relative increase in exceedance frequency at Barker Slough, the difference between operational scenarios is very small. Regardless of particular Alternative 4 operational scenario, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Scenarios H1–H4 of Alternative 4 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, change would be greatest for Scenarios H1 and H3, where predicted long-term average bromide concentrations would increase from 103 μg/L to 155 μg/L (51% increase) at City of Antioch and would increase from 150 μg/L to 201 μg/L (41% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Under Scenarios H2 and H4, predicted increases would also occur, but would be somewhat less, with approximate 40% increases at the City of Antioch and approximate 34% increases at Mallard Slough. Increases would be similar for the No Action Alternative comparison, with slightly lower relative increases at City of Antioch (i.e., 33–44% depending on operational scenario), and slightly higher relative increases at Mallard Slough (i.e., 36–47% depending on operational scenario). Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which is reflected in the modeling—see Section 8.3.1.3, *Plan Area*), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under the various operational scenarios of Alternative 4, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with the largest improvement predicted to occur under Scenario H4 and the smallest improvement predicted to occur under Scenario H1. Under Scenario H4, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 46% relative to Existing Conditions and 38% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H4 would be less during drought conditions (≤36%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 10). Decreased long-term average bromide concentrations under the other operational scenarios would also be predicted, but would be slightly less. Under Scenario H1, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 37% relative to Existing Conditions and 28% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H1 would be less during drought conditions (≤28%) (Appendix 8E, *Bromide*, Table 10). As a result, and regardless of operational scenario, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, Table 11).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. This substantial degradation would be predicted to occur regardless of operational scenario, but would be greatest under Scenario H2. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects. Implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Operational Scenarios H1–H4 of Alternative 4 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under any operational scenario of Alternative 4 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under all operational scenarios of Alternative 4, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, all operational scenarios of Alternative 4 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations under all operational scenarios would be predicted, but would be greatest for Scenario H2. While the predicted increase in long-term average bromide concentrations at Barker Slough would be greatest for Scenario H2, the relative increases regardless of particular operational scenario would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades could be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under all of the operational scenarios of Alternative 4, substantial improvement would occur at the Banks and Jones pumping plants, where long-term average bromide concentrations are predicted to decrease by as much as 44% relative to Existing Conditions. As a result, an overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under all of the operational scenarios of Alternative 4, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. The operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by as much as 40%, and 98% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to as much as 20% under Alternative 4, while for the modeled drought period, the frequency would increase from 0% to as much as 47%. The substantial changes in long-term average bromide predicted for Barker Slough under all operational scenarios of Alternative 4 could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-5, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions; Site and Design Restoration Sites to Reduce Bromide Increases in Barker Slough

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 4. Therefore, in order to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4. The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on bromide concentrations in Barker Slough. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. It is anticipated that these efforts will be able to reduce the level of projected increase, though it is unknown whether it would be able to completely eliminate any increases.

Additionally, following commencement of initial operations of CM1, the project proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the increased bromide concentrations currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased bromide concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. If sufficient operational flexibility to offset bromide increases is not feasible under Alternative 4 operations, and/or siting and design of restoration areas cannot feasibly reduce bromide increases to a less-than-significant level without compromising the benefits of the proposed areas, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 4 would not present new or substantially changed sources of bromide to the study area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-5).

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

In summary, implementation of CM2–CM21 under Alternative 4, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of CM2–CM21 under Alternative 4 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–CM21 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–CM21 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. This impact is therefore considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions (in association with the different components of Operational Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and be similar compared to the No Action Alternative (considering only changes due only to the different components of Operational Scenarios H1–H4 under Alternative 4). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62).

Consequently, the Alternative 4 H1–H4 Scenarios would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling predicts that the Alternative 4 H1–H4 Scenarios would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations. The mass-balance modeling results indicate similar, but slightly larger increases in chloride concentrations compared to estimates generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3). Increased long-term average chloride concentrations would occur at the North Bay Aqueduct at Barker Slough (i.e., range from up to 33% [H2] to 16% [H3]) and SF Mokelumne River at Staten Island (i.e., similar increase of 22–23% for all H1–H4 Scenarios) (Appendix 8G, *Chloride*, Tables Cl-25A through 25D [mass balance model results] and Tables Cl-26A through 26D [EC-chloride relationship results]). Changes in long-term average concentrations in the western Sacramento River at Emmaton would range from an increase for Scenarios H1 and H2 (14 to 16%) to no measureable change for Scenarios H3 and H4 (i.e., -1%). Long-term average chloride concentration would decrease at other assessment locations, with the largest reductions occurring under Scenarios H3 and H4 (i.e., up to -24% at Franks Tract) and less reduction under Scenarios H1 and H2 (i.e., up to -12% at Franks Tract). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both the different components of Operational Scenarios H1–H4 for Alternative 4 and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that the Alternative 4 Scenarios H1–H4 would result in similar increases in long-term average chloride concentrations for the 16-year period as described above compared to Existing Conditions: SF Mokelumne River at Staten Island (i.e., up to 25 to 27% for all H1–H4 Scenarios), North Bay Aqueduct at Barker Slough (i.e., range of 20% [H3] up to 37% [H2]), and for the Sacramento River at Emmaton (i.e., ranging from an increase for Scenarios H1–H2 of up to 17% to reduction under Scenarios H3–H4 [-1%]) (Appendix 8G, Table Cl-25A through 25D [mass balance model results] and Tables Cl-26A through 26D [EC-chloride relationship results]). Relative to the No Action Alternative, the long-term average chloride concentrations based on EC to chloride relationships indicate that most of the other interior and western Delta assessment locations under Scenarios H1 and H2 would exhibit similar increases ranging from up to 3% at San Joaquin River at

Buckley Cove to 9% at the Sacramento River at Mallard Island. The comparison to the No Action Alternative reflects chloride changes due only to the different components of Operational Scenarios H1–H4 for Alternative 4.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For the Alternative 4 Scenarios H1–H4, the modeled frequency of objective exceedance would be unchanged relative to Existing Conditions at the Contra Costa Pumping Plant #1 at 7% (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 4, the modeled frequency of objective exceedance would decrease similarly for the H1–H4 Scenarios by approximately one half, from 6% of modeled days under Existing Conditions, to 3–4% of modeled days under the Alternative 4 operational scenarios (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 from an exceedance frequency of 24% under Existing Conditions to a range of 18% (for H1) to 12–13% (for H3 and H4) (Appendix 8G, Table Cl-27 and Figure Cl-5). However, the frequency of exceedances would increase slightly for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 68% to 70% for the H1–H4 Scenarios) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 86% to 88% for the H1–H4 Scenarios) (Appendix 8G, Table Cl-27). Although these changes are within the uncertainty of the modeling approach, the mass balance results also indicate that the increased concentrations would reduce assimilative capacity with respect to the 250 mg/L objective, thus causing further degradation at Antioch in March and April, with similar maximum reductions under H1 and H3 of up to54% to maximum reductions of up to 42% for H3 and H4 for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, for all of the H1–H4 Scenarios during the drought period modeled) (Appendix 8G, Tables Cl-29A through 29D and Figure Cl-5). Assimilative capacity at the Contra Costa Canal at Pumping Plant #1 also would be similarly reduced in September and October under the H1 and H2 scenarios (i.e., up to 100%, or elimination) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Figure Cl-5), but would not be substantially reduced under the H3 or H4 scenarios.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Table Cl-28 and Tables Cl-30A through 30D). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4 H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine Slough in the south Delta, would generally be similar under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions in the months of March through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-7), Mallard Island (Appendix 8G, Figure Cl-5), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-8). Although modeling of Alternative 4 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 4, the modeled frequency of objective exceedance would increase at the Contra Costa Pumping Plant #1 from 0% under the No Action Alternative to 7% of years under all of the Alternative 4 H1–H4 Scenarios (Appendix 8G, Table Cl-64). The increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 10 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. For Alternative 4, the modeled frequency of objective exceedance would decrease minimally under all the H1–H4 Scenarios, from 5% of modeled days under the No Action Alternative to 4–3% of modeled days under the Alternative 4 scenarios (Appendix 8G, Table Cl-64).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small increase in exceedance frequency would be predicted at the Sacramento River at Mallard Island (i.e., from 86% for the No Action Alternative to a slight 2% increase [up to88%] for H1 and H3), with no change in exceedances under H2 or H4 (Appendix 8G, Table Cl-27). The frequency of exceedances would decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to a range of 68% [H2 and H4] to 70% [H1]), and the frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would depend on the scenario from 14% under the No Action Alternative increasing by 2–4% for H1 and H2 (i.e., up to 18%) and decreasing at H3 and H4 [to 12%]) (Appendix 8G, Table Cl-27). Although these changes are within the uncertainty of the modeling approach, substantial reductions in available assimilative capacity compared to the No Action Alternative condition would occur at Antioch under H1 and H3 (i.e., 24% in April) and no substantial reduction under H2/H4 for the 16-year period modeled, and up to 100% in April [i.e., eliminated] for the drought period for all H1–H4 scenarios). Assimilative capacity also would be reduced substantially at the Contra Costa Canal at Pumping Plant #1 at similar levels for H1 and H2 in August through November (i.e., up to 100% elimination in October) to only in August and September under H3 and H4 (i.e., up to 29%) for the 16-year period modeled, with 100% elimination in at least one month under all of the H1–H4 scenarios for the drought period) (Appendix 8G, Tables Cl-29A through 29D), reflecting substantial degradation during months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, Tables Cl-30A through 30D). However, as with Alternative 1A, the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4 H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride for Tom Paine Slough, Alternative 4 would generally result in similar changes for all of the Alternative 4 H1–H4 Scenarios to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at the Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6).

Modeling results indicate that monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-5, Cl-7, and Cl-8) would increase substantially in some months during October through May compared to the No Action Alternative conditions, but sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under the Alternative 4 H1–H4 Scenarios, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease compared to Existing Conditions. Reductions at Banks would be slightly larger than at Jones, ranging from 37% (H1) to 45% (H4) (Appendix 8G, *Chloride*, Table Cl-25A through 25D). Compared to No Action Alternative, the pattern of reductions would be similar with Banks ranging from 32% (H1) to 38% (H4). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-27). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3, *Plan Area*) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Tables Cl-26A through 26D [for concentration changes] and Table Cl-28 [for frequency of exceedances]).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, the Alternative 4 H1–H4 Scenarios are not expected to result in substantial additional exceedances of the 150 mg/L or 250 mg/L water quality objectives. All of the Alternative 4 H1–H4 Scenarios would result in increased water quality degradation with respect to the 250 mg/L municipal and industrial objective at western Delta locations on a monthly average basis, and could contribute measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). The predicted chloride increases constitute an adverse effect on water quality. Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under the Alternative 4 H1–H4 Scenarios would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under any of the Alternative 4 H1–H4 Scenarios, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 4 H1–H4 Scenarios would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 4 H1–H4 Scenarios would not increase the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective. Modeling results indicate that the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (ranging by up to 2 to 4% for the H1–H4 Scenarios), but these frequencies are expected to be within the uncertainty present in the chloride modeling procedure. Substantial long-term degradation may occur at Antioch under all of the H1–H4 Scenarios, and at the Contra Costa Canal at Pumping Plant #1 under the H1-H2 Scenarios, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7; implementation of this measure along with a separate, other commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta under all of the

H1–H4 Scenarios could further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced under all of the H1–H4 Scenarios in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 4 H1–H4 Scenarios would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 4 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its potential effects on municipal and industrial water supply and fish and wildlife beneficial uses.

Implementation of Mitigation Measure WQ-7 along with a separate, other commitment relating to the potential increased costs associated with chloride-related changes would reduce these effects. Although it is not known whether implementation of WQ-7 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Based on sensitivity analyses conducted to date (see Appendix 8H, Attachment 1), it is expected that implementation of Mitigation Measure WQ-7d would reduce impacts on chloride in Suisun Marsh to a less-than-significant level.

In addition to and to supplement Mitigation Measure WQ-7, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations and/or site-specific design of tidal restoration areas under CM4. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.

Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation shall continue to monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. DWR and Reclamation have a good history of compliance with water quality objectives (see Sections 8.1.3.4 and 8.1.3.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in Sections 8.3.1.1 and 8.3.1.3), it is likely that objective exceedance, should any be predicted to occur, could be avoided through real-time operation of the SWP and CVP.

Nevertheless, water quality degradation could occur that may not be addressed through real-time operations. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4.

Mitigation Measure WQ-7a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The project proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation relative to the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 4. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-7b. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 4.

Mitigation Measure WQ-7b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation with respect to the 250 mg/L chloride objective in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-7a. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 4.

Mitigation Measure WQ-7c: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets Applicable Water Quality Objectives

To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the project proponents will consult with the purveyors to identify any feasible operational means to either avoid, minimize, or offset for reduced seasonal availability of water that either meets applicable water quality objectives or that results in levels of degradation that do not substantially increase the risk of adversely affecting the municipal and industrial beneficial use. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any potentially feasible actions described in Mitigation Measure WQ-7a and WQ-7b.

Mitigation Measure WQ-7d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce Chloride Concentration Increases in the Marsh

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. The project proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. These actions are identical to the actions discussed in Mitigation Measure WQ-11b regarding levels of electrical conductivity in Suisun Marsh.

Mitigation Measure WQ-7e: Implement Terms of the Contra Costa Water District Settlement Agreement

DWR and Contra Costa Water District (CCWD) entered into a settlement agreement (Agreement) for reducing potential impacts to CCWD water supply in the Delta related to construction and operation of the BDCP/California WaterFix. This mitigation measure includes conveyance of water to CCWD that meets specified water quality requirements, in quantities and on a schedule defined in the Agreement. The Agreement ensures that the quality of the water CCWD delivers to its customers is not impacted as a result of the BDCP/California WaterFix. The Agreement does not increase the total amount of water that CCWD would otherwise be entitled to divert.

DWR would convey mitigation water to CCWD in one of two ways: 1) the primary method of conveying the water would be through the existing Freeport Regional Water Authority Intake (Freeport Intake) and the existing interconnection between EBMUD's Mokelumne Aqueduct and CCWD's Los Vaqueros Pipeline; and 2) the secondary method of conveying the water would be through the BDCP/California WaterFix's northern intakes and new Interconnection Facilities between the water conveyance facilities and existing CCWD facilities. Two different options for the new Interconnection Facilities are being considered: one on Victoria Island between the water conveyance facilities and the existing CCWD Middle River pipeline; and one at Clifton Court Forebay between the Clifton Court Forebay and the CCWD Los Vaqueros pipeline. No new facilities are required for the EBMUD/Freeport Intake conveyance method. DWR would be responsible for design and construction of the Victoria Island or Clifton Court Forebay facilities.

The Agreement requires an initial conveyance to CCWD of 30 TAF of water. For each year after the initial conveyance, a specified amount of water based on the prior year's operations would be conveyed in arrears. Under the Agreement, CCWD would take the same quantity of water that it would take absent the agreement, but the location and timing of diversions would change. Annual average diversions of mitigation water would be on the order of 30 TAF, and the rate of diversion of the mitigation water would be 150 cfs, with a maximum rate of diversion of 250 cfs upon mutual agreement between DWR and CCWD.

Additional description of the Agreement actions and analysis of the potential effects of this mitigation measure are provided in Appendix 31B. Terms of the Agreement are presented in Attachment 1 to Appendix 31B.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** The implementation of the other conservation measures (i.e., CM2–CM21), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12–CM21 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of CM2–CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to the No Action Alternative.

In summary, based on the discussion above, the effects on chloride from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion**:** Implementation of the CM2–CM21 for Alternative 4 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

DO levels in the reservoirs and rivers are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

A reservoir can exhibit seasonal changes in the DO profile from the water surface to the sediments that is affected by its degree of thermal stratification, where oxygenated inflows enter and mix with the reservoir, its level of productivity that contributes DO through photosynthesis and consumes DO through respiration and decomposition, as well as the prevailing winds that cause mixing within the reservoir. Water temperature also is a factor in that it affects the level (between the surface and the bottom) at which oxygenated river inflows enter the reservoir, the DO saturation level, and photosynthesis and respiration rates. Cold inflows tend to move deep into the reservoir due to the lower density of cold water, whereas warm water inflows tend to mix with the surface waters, particularly when the reservoir is thermally stratified. Under Alternative 4, the primary factor that would change relative to Existing Conditions is that end-of-September carryover storage may be lower in some years (see Chapter 5, *Water Supply*, Section 5.3.3.9), which would affect the temperature profile of the reservoirs at the end of summer. Nevertheless, the reservoirs would continue to thermally stratify seasonally, as they do under Existing Conditions. Given the size of the reservoirs—Lake Oroville, Trinity Lake, Shasta Lake, and Folsom Lake—and their significant surface area, inflows and wind fetch that would still contribute to oxygenating these water bodies, the lower carryover storage that could occur in some years under Alternative 4 is not expected to cause DO depletions or substantial changes in DO that would adversely affect the beneficial uses of these water bodies.

The four operational scenarios of Alternative 4 would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which would consequently alter downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under Existing Conditions and the No Action Alternative. Moreover, these are large, turbulent rivers with flow velocities typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under any operational scenario of Alternative 4 would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative.

The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative, could affect downstream river temperatures, depending on month and year. Water temperature affects the maximum DO saturation level; as temperature increases, the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5 mg/L at 30°C (86°F) to 11 mg/L at 10°C (50°F) (Tchobanoglous and Schroeder 1987:735). As described in Section 8.1, *Environmental Setting/Affected Environment*, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under any operational scenario of Alternative 4 would not be expected to cause DO levels to be outside of the range seen historically. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain saturation levels.

Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under Alternative 4 to substantially alter DO levels relative to Existing Conditions or the No Action Alternative. Any minor reductions in DO levels that may occur under this alternative would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under any of the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative.

Delta

Similar to the reservoirs and rivers upstream of the Delta, DO levels in the Delta are primarily affected by water temperature, salinity, Delta channel flow velocities, nutrients (i.e., phosphorus and nitrogen) and aquatic organisms (i.e., photosynthesis, respiration, and decomposition). Sediment oxygen demand of organic material deposited in the low velocity channels also affects Plan Area DO levels.

Under all operational scenarios of Alternative 4, minor DO level changes could occur due to nutrient loading to the Delta relative to Existing Conditions and the No Action Alternative (see WQ-1, WQ-15, WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (see Table 8-11). Based on these considerations, excessive nutrients that would cause low DO levels would not be expected to occur under any operational scenario of Alternative 4.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (see WQ-11) For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under

Alternative 4 would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In general, waters of the Delta would be expected to warm less than 5 degrees F under Alternative 4, relative to Existing Conditions, due to climate change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature under Alternative 4 due to climate change would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Some waterways in the eastern, southern, and western Delta, and Suisun Marsh are listed on the state's Clean Water Act Section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Regional Water Quality Control Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on sources and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project.

In the Deep Water Ship Channel, low DO events have historically occurred in May-October, and typically in drier years and when flows in the San Joaquin River at Stockton are less than 1,000 cfs (Central Valley Regional Water Quality Control Board 2014, ICF International 2010). Concerns have been raised that flows on the San Joaquin River at Stockton may increase, causing the location of the minimum DO point to shift downstream.

Figure 8-65a shows a box-and-whisker plot of the monthly average flows in the San Joaquin River at Stockton for the months of May–October for Dry and Critical water year types. The figure shows that while flows do change somewhat, they are generally within the range of flows seen under Existing Conditions. Reports indicate that the aeration facility performs adequately under the range of flows from 250–1,000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will likely still be located appropriately to keep DO levels above Basin Plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact on DO in the Deep Water Ship Channel. It is expected that under Alternative 4 that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions and the No Action Alternative or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act Section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No Action Alternative, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

SWP/CVP Export Service Areas

The primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP Export Service Areas would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. For reasons provided above, the Delta waters exported to the SWP/CVP Export Service Areas would not be expected to be substantially lower in DO compared to Existing Conditions or the No Action Alternative. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions or the No Action Alternative (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs. Consequently, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur.

NEPA Effects**:** The effects on DO from implementing any operational scenario of Alternative 4 is determined to not be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Reservoir storage reductions that would occur under any operational scenario of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta. CM13 proposes to use a variety of methods to control invasive aquatic plants, of which herbicide spraying is one option. The area of treatment that would be funded by the conservation measure would be 1,700–3,300 acres (see Section 3.6.3.2 of Chapter 3, *Description of Alternatives*), a limited area relative to the entire area of the Delta surface waters. Further, as described in Section 3.6.3.2 of Chapter 3, avoidance and minimization measures would be adopted and would likely be similar to those conditions identified in the existing CDBW program (including the associated biological opinion and EIR), which restrict where and when herbicide treatment may be implemented, establish allowable chemical concentrations in treated areas and adjacent water, and require extensive water quality monitoring. Thus, based on the size of the area to be treated and the measures to be used, this conservation is not considered to have an adverse effect on DO in the Delta that would adversely affect beneficial uses. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances.

The effects on DO from implementing CM2–CM21 is determined to not be adverse.

***CEQA Conclusion*:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–CM21 under Alternative 4 would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to Existing Conditions or the No Action Alternative. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed. Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions or the No Action Alternative.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agricultural use of irrigation water imported from the southern Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Depending on operational scenario, long-term average flows at Vernalis would decrease about 6% (as a result of climate change and increased water demands) relative to Existing Conditions, and would increase about 0.1% relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3% relative to Existing Conditions, and less than 0.1% relative to the No Action Alternative. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that long-term EC levels will improve. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions or the No Action Alternative would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of

CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Relative to Existing Conditions, modeling indicates that Alternative 4, Scenarios H1–H4, would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point, and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 27–29%, depending on the operations scenario, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 40–43%, depending on the operations scenario. Although these results are for modeling that was originally performed for Alternative 4 assuming the Emmaton compliance point shifted to Threemile Slough, Alternative 4 now does not include a change in compliance point from Emmaton to Threemile Slough. Sensitivity analyses were performed that modeled Alternative 4 Scenario H3 with Emmaton as the compliance point. Assuming the compliance location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased exceedances at Emmaton from 28% to 15% under Alternative 4, Operational Scenario H3 (see Appendix 8H, Attachment 1 for more discussion of these sensitivity analyses), which would still be greater than Existing Conditions. Table 2 of Appendix 8H, Attachment 1 indicates that most of these exceedances are a result of modeling artifacts, but some exceedances are due to dead pool conditions that occurred in 1977, 1981, and 1990 under Alternative 4 and not under Existing Conditions. As discussed in Chapter 5, *Water Supply*, Section 5.3.1, *Methods for Analysis*, under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, CALSIM II uses a series of operating rules to reach a solution that is a simplified version of the very complex decision processes that SWP and CVP operators would use in actual extreme conditions. Thus, it is unlikely that the Emmaton objective would actually be violated due to dead pool conditions. However, these results indicate that water supply could be either under greater stress or under stress earlier in the year, and EC levels at Emmaton and in the western Delta may increase as a result, leading to EC degradation and increased possibility of adverse effects to agricultural beneficial uses.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% to 3–6%, depending on the operations scenario. The percentage of days out of compliance with the EC objective for San Andreas Landing would increase from 1% to 5–9%, depending on the operations scenario. Sensitivity analyses performed indicate that many of these exceedances are modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP).

The percentage of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% to 21–31% and the percentage of days out of compliance with the EC objective would increase from 10% to 25–33%, depending on the operations scenario. At Jersey Point, the percentage of days the EC fish and wildlife objective would be exceeded for the entire period modeled would increase from 0% to 0–2%, and the percentage of days out of compliance with the EC objective would increase from 0% to 0–2%, depending on operations scenario. Sensitivity analyses conducted indicate that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing

Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). Appendix X8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

The increase in percentage of days exceeding the EC objectives and days out of compliance at the Old River locations would be 1–2% at Tracy Bridge and less than 1% at Middle River for all operations scenarios. Sensitivity analyses performed indicated that many of these exceedances are modeling artifacts, and modeling barrier installation assumptions consistent with historical dry year practices of installing barriers earlier in the year could resolve these additional exceedances (see Appendix 8H, Attachment 1, for a discussion of these sensitivity analyses). Furthermore, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations would decrease, except at Emmaton, from 1–36% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, Tables EC-15A through EC-15D). At Emmaton, there would be an increase in average EC under all operational scenarios, though the increase would be less for Scenarios H3 and H4 (0% for entire period; 8% for drought period) than for Scenarios H1 and H2 (13–14% for entire period; 12–13% for drought period). There would be increases in average EC at two interior Delta locations under all operational scenarios: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 0–9% for the entire period modeled and 7–13% during the drought period modeled. In addition, under Scenarios H1 and H2, there would be slight increase (<1–2%) in drought period average EC in the San Joaquin River at Prisoners Point. On average, EC would increase at San Andreas Landing from March through September under all operations scenarios; Scenarios H1, H2, and H4 also would increase EC at this location in February and Scenarios H1 and H2 would increase EC in October. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 14–15% for the entire period modeled (Appendix 8H, Tables EC-15A through EC-15D). The comparison to Existing Conditions reflects changes in EC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenarios H1–H4) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4). The increase in percentage of days exceeding the EC objective would be 20–30% at Prisoners Point, depending on the operations scenario, and 15% or less at the remaining locations. The increase in percentage of days out of compliance would be 24–32% at Prisoners Point, depending on the operations scenario, and 17% or less at the remaining locations. In general, the changes in frequency of exceedances of EC objectives relative to the No

Action Alternative would be similar to those discussed above relative to Existing Conditions, and thus the conclusions of the sensitivity analyses discussed above extend to the comparison to the No Action Alternative. The exception to this is for Emmaton. As discussed above, assuming the compliance location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased the frequency of objective exceedances at Emmaton from 28% to 15% under Alternative 4, Operational Scenario H3 (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). This frequency of objective exceedance is very similar to the frequency of exceedances under the No Action Alternative, which would be 13%. Nevertheless, Table 2 of Appendix 8H, Attachment 1, indicates that exceedances due to deadpool conditions in 1981 and 1990 occurred under Alternative 4 and not under the No Action Alternative. As discussed above, it is unlikely that the Emmaton objective would actually be exceeded due to dead pool conditions. However, these results indicate that water supply conditions could be either under greater stress or under stress earlier in the year, and EC levels at Emmaton and in the western Delta may increase as a result, leading to EC degradation and increased possibility of adverse effects on agricultural beneficial uses. The frequency and magnitude of increased EC levels relative to the No Action Alternative at Emmaton is lower than relative to Existing Conditions, because climate change and sea level rise present in both the No Action Alternative and Alternative 4 contribute to the extreme hydrologic conditions in several years.

For the entire period modeled, average EC levels would increase at western (Scenarios H1 and H2 only), interior, and southern Delta locations; the average EC increase would be 12–13% at Emmaton (western Delta; for Scenarios H1 and H2 only), 5–15% at interior Delta locations and 2% or less at southern Delta locations, depending on the operations scenario (Appendix 8H, Tables EC-15A through EC-15D). During the drought period modeled, average EC would increase at western (Scenarios H1 and H2 only), interior, and southern Delta locations. The greatest average EC increase during the drought period modeled would occur in the interior Delta in the San Joaquin River at San Andreas Landing (7–13% depending on the operations scenario); the increase at the other locations would be <1–9% (Appendix 8H, Tables EC-15A through EC-15D). The comparison to the No Action Alternative reflects changes in EC due only to the different components of Operational Scenarios H1–H4 of Alternative 4.

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Modeling data indicate that average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March through May under all operations scenarios of Alternative 4, relative to Existing Conditions, by 0.3–0.9 mS/cm (Appendix 8H, Table EC-21). Long-term average EC would decrease under all operations scenarios, relative to Existing Conditions, in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial EC increase would occur near Beldon's Landing, with long-term average EC levels increasing by 1.3–6.0 mS/cm, depending on the month and operations scenario, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months ranging 0.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of Alternative 4 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results discussed above, but EC levels were still somewhat higher than EC levels under

Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4,would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 4.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 23–27% for the entire period modeled and 21–27% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease, by 17–22% for the entire period modeled and 16–22% during the drought period modeled. (Appendix 8H, Tables EC-15A through EC-15D)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 21–26% for the entire period modeled and 17–23% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease by 17–22% for the entire period modeled and 14–20% during the drought period modeled. (Appendix 8H, Table EC-15A through EC-15D).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4, would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 4, Scenarios H1–H4, would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 4, Scenarios H1–H4, would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

***NEPA Effects*:** In summary, based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the western, interior, or southern Delta. However, modeling results indicate that there could be increased long-term and drought period average EC levels that would occur in the western Delta under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative, that would contribute to adverse effects on the agricultural beneficial uses. The increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA Section 303(d) listed as impaired due to elevated EC, and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects. Implementation of this measure along with a separate, other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects. Specifically, Mitigation Measure WQ-11d would be expected to reduce effects in Suisun Marsh to a level that would not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 4, Scenarios H1–H4, would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991) in the San Joaquin River at Jersey Point, and the San Joaquin River at Prisoners Point. Though objective exceedance would likely not occur in the Sacramento River at Emmaton, average EC levels at Emmaton would increase by <1–14% for the entire period modeled and 8–13% during the drought period modeled. These increases in long-term and drought period average EC levels would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The comparison to Existing Conditions reflects changes in EC due to both Alternative 4 operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton would be due in part to the effects of climate change/sea level rise, and in part due to Alternative 4 operations. This is evidenced by the significant effects expected in the No Action Alternative at Emmaton relative to Existing Conditions (see Section 8.3.3.1, Impact WQ-11), as well as the fact that a lesser level of adverse effects is expected at Emmaton under Alternative 4 relative to the No Action Alternative (see “NEPA Effects” section above). Based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the interior or southern Delta, or that increased long-term and drought period average EC levels that would occur in these areas, relative to Existing Conditions, would contribute to adverse effects on the agricultural beneficial uses. The increased frequency of exceedance of the fish and wildlife objective at Jersey Point and Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are CWA Section 303(d) listed for elevated EC and the increased EC degradation that could occur in the western Delta could make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 4, Scenarios H1–H4, could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA Section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant. However, based on sensitivity analyses conducted to date (see Appendix 8H, Attachment 1), it is expected that implementation of Mitigation Measure WQ-11d would reduce impacts on EC in Suisun Marsh to a less-than-significant level.

Implementation of Mitigation Measure WQ-11 along with a separate, other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. Although it is not known whether implementation of WQ-11 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of Mitigation Measure WQ-11d would reduce impacts on EC in Suisun Marsh to a less-than-significant level.

In addition to and to supplement Mitigation Measure WQ-11, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

In order to reduce the effects of increased EC levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate feasible actions, followed by development and implementation of the actions, if determined to be necessary. The emphasis and mitigation actions would be limited to those identified as necessary to avoid, reduce, or offset adverse EC effects at Delta compliance locations and the Suisun Marsh. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental EC effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4. The goal of specific actions would be to reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average concentration increases to levels that would not adversely affect beneficial uses within the Delta and Suisun Marsh.

Mitigation Measure WQ-11a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The project proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation in the western Delta currently modeled to occur under Alternative 4. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-11b. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4. These actions are identical to the actions discussed in Mitigation Measure WQ-7a regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4. These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11c: Design Restoration Sites to Reduce Effects on Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to Determine Whether Additional Actions are Warranted

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on compliance with the fish and wildlife EC objective between Jersey Point and Prisoners point on the San Joaquin River. Design of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. Additionally, following commencement of initial operations of CM1, the project proponents will evaluate ongoing monitoring of striped bass populations, and, specifically spawning in the San Joaquin River between Jersey Point and Prisoners Point, and will conduct such monitoring if it is not already being conducted by CDFW at that time. The project proponents will consult with CDFW, USFWS, and NMFS to determine whether adaptive changes to Head of Old River Barrier operations and/or changes in North Delta vs. South Delta exports are warranted to avoid adverse impacts of salinity on striped bass spawning in the San Joaquin River. Because these actions may have adverse effects on other species, consultation is required, and the changes may not be warranted depending on conditions of striped bass populations and populations of other species at that time.

Mitigation Measure WQ-11d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce EC Level Increases in the Marsh

The project proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. The project proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased EC levels. These actions are identical to the actions discussed in Mitigation Measure WQ-7d regarding levels of chloride in Suisun Marsh.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

NEPA Effects**:** The implementation of the other conservation measures (i.e., CM2–CM21) present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–CM21 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment.

The effects on EC from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion**:** Implementation of CM2–CM21 under Alternative 4 would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–CM21 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of CM2–CM21 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under the various Alternative 4 scenarios (H1–H4), greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figure I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under the operational scenarios of Alternative 4 relative to Existing Conditions and No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or No Action Alternative due to changes in flows under the operational scenarios of Alternative 4.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

The water quality impacts of waterborne concentrations of mercury (Appendix 8I, Table I-5) and methylmercury (Appendix 8I, Table I-6) and fish tissue mercury concentrations (Appendix 8I, Tables I-11A through I-11D) were evaluated for nine Delta locations.

The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 4 scenarios as compared to Existing Conditions showed the greatest decrease to be of -2.4% in the Old River at Rock Slough and the Contra Costa Pumping Plant for scenario. These are bounded by Alternative 4 H1 estimates of -1.4% and -1.5% at these two locations, respectively. In contrast the greatest increase in assimilative capacity relative to Existing Conditions was 4.4% for H4 at the Jones Pumping Plant (Figures 8-53a through 8-54b). Scenarios H2 and H3 range in changes in assimilative capacity in relation to Existing Conditions from -2.1% (H3 at Contra Costa Pumping Plant to 4.1) (H2 at Banks). These small changes in assimilative capacity are not expected to result in adverse (or positive) effects to beneficial uses.

As compared to the No Action Alternative, Alternative 4 H4 showed the greatest range in changes in assimilative capacity for total mercury; ranging from 5.0% at the Jones Pumping Plant to -2.3% at the Old River site. These same sites show the smallest range of effects for Alternative 4 H1; with 4.3% and -1.4% for these same two stations, respectively. Scenarios H2 and H3 fall between these extremes. However, these small ranges of changes are not expected to result in adverse effects to beneficial uses.

All methylmercury concentrations in water were estimated to exceed TMDL guidelines and no assimilative capacity exists. Changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L for the San Joaquin River at Buckley Cove (all scenarios) which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-6). In general, the Alternative 4 H4 conditions were highest in concentration and Alternative 4 H1 was lowest, as compared among scenarios for modeled methylmercury concentrations in water. All modeled concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L; therefore, percentage change in assimilative capacity was not evaluated for methylmercury.

Similar to waterborne methylmercury, fish tissue mercury concentration estimates all exceed TMDL guidelines. Percentage changes were somewhat larger than for waterborne concentrations, but not expected to result in changes to beneficial use. Fish tissue estimates show only small or no increases in EQs based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, Tables I-11Aa through I-11Db). The greatest increase over Existing Conditions was for Scenario H4 and was 15% at Old River at Rock Slough and 13% for Franks Tract as compared to H1 estimates for both of those locations of 9% (Tables 1-11Ab through I-11Db). In comparison to the No Action Alternative, the greatest increases in concentrations mirrored the Existing Condition comparisons and were estimated to be 12% for Old River at Rock Slough, and 12% for Franks Tract. Scenario H1 provided the lowest set of percentage changes in bass mercury for those locations (Figures 8-55a and 8-55b; Appendix 8I, Tables I-11Aa through I-11Db). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 4, all scenarios, at the Jones and Banks pumping plants, were lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures I-4 and I-5). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a through 8-54b). The greatest increase was 5% for Scenario H4 for Jones Plant (compared to No Action); the least was H2 at Banks of 2.9% (compared to Existing Conditions).

The largest improvements in bass tissue mercury concentrations and EQs for Alternative 4, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations. The greatest improvement in bass tissue mercury concentration are expected for Scenario H4 at the Banks and Jones pumping plants (-14% and -16%, respectively) (Figures 8-55a, and 8-55b; Appendix 8I, Tables I-11Aa through I-11Db).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Scenarios H1–H4 of Alternative 4 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 4, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 4 scenarios as compared to Existing Conditions for Delta sites. The greatest changes in assimilative capacity and tissue mercury estimates were for Scenario H4; these least for Scenario H1.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 4, all scenarios, as compared to Existing Conditions.

As such, none of the H1–H4 scenarios for this alternative are expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 4 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities under Alternative 4 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 4 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 4 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3, *Plan Area*) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 4.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site (this approach could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, this would run directly counter to the goals and objectives of the BDCP. This approach should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas),
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where feasible, to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, in the Delta, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in waterborne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 4 would be guided by CM12 which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed, nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many dischargers have already improved facilities to remove more nitrate, many others are likely to do so over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport (Appendix 8J, *Nitrate*, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under various operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San

Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49; see Appendix 8J, *Nitrate*, Figure 2). Under Alternative 4, Scenarios H1–H4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under any operational scenario of Alternative 4.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Mixing calculations indicate that under Alternative 4 (including the different components of Operational Scenarios H1–H4), relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 16, 17A through 17D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50**.** Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 4 relative to Existing Conditions, and slightly increased relative to the No Action Alternative. Regardless of operational scenario, no additional exceedances of the MCL are anticipated at any location under Alternative 4 (Appendix 8J, *Nitrate*, Table 16).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under the four operational scenarios of Alternative 4 is low or negligible (i.e., <5%) in comparison to both Existing Conditions and the No Action Alternative, for all locations and months, for all modeled years, and for the drought period (Appendix 8J, *Nitrate*, Table 18A through 18D). One exception is for Buckley Cove on the San Joaquin River in August, where use of assimilative capacity available during the drought period (1987–1991) relative to the No Action Alternative for the four operational scenarios of Alternative 4 ranged from 6.3% to 6.5%.

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Regional Water Quality Control Board 2010a:32).
- Under the four operational scenarios of Alternative 4, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under the four operational scenarios of Alternative 4, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification upgrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and the four operational scenarios of Alternative 4, the increase is expected to be greater under Existing Conditions than for the four operational scenarios of Alternative 4 due to the upgrades that are assumed under the four operational scenarios of Alternative 4.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

In summary, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that the change in nitrate concentrations and use of assimilative capacity are similar for the four operational scenarios of Alternative 4 (Appendix 8J, *Nitrate*, Tables 16, 17A through 17D, 18A through 18D). Relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants under Alternative 4 are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Tables 17A through 17D). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, *Nitrate*, Table 16). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<5%) for both Banks and Jones pumping plants (Appendix 8J, *Nitrate*, Table 18A through 18D).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under the four operational scenarios of Alternative 4 (H1 through H4), relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all operational scenarios for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 4 (including the different components of Operational Scenarios H1–H4), relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <5%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 4 are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM21 is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

The effects on nitrate from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 under Alternative 4, Scenarios H1–H4, relative to Existing Conditions. Because urban stormwater is a source of nitrate in the affected environment, *CM19, Urban Stormwater Treatment*, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under the various operational scenarios of Alternative 4 would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Scenarios H1–H4 of Alternative 4, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Under the four operational scenarios of Alternative 4, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to those previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. For all the operational scenarios relative to Existing Conditions, the modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. Increased long-term average DOC concentrations at these locations would be greatest under Scenario H4 and would be least under Scenario H1, although differences would be generally small between operational scenarios (i.e., ≤0.2 mg/L). Under Scenario H4, long-term average DOC concentrations for the modeled 16-year hydrologic period and the modeled drought period would be predicted to increase between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (≤14% net increase) (Appendix 8K, *Organic Carbon,* DOC Table 5). Under Scenario H4, increases in long-term average concentrations of between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 76% under Scenario H4 of Alternative 4 (an increase from 47% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 38% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 81% under Scenario H4 of Alternative 4 (45% to 78% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 47% for the drought period). Relative change in frequency of threshold exceedance for the other operational scenarios and at other assessment locations would be similar or less. While all of the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations (≤0.5 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different components of Operational Scenarios H1–H4) and climate change/sea level rise.

In comparison, relative to the No Action Alternative, the operational scenarios of Alternative 4 would generally result in a magnitude of change similar to that discussed for the Alternative 4 operational scenario comparison to Existing Conditions. Scenario H4 would generally lead to the largest model predicted long-term average DOC concentration increases, and Scenario H1 would generally lead to the smallest model predicted increases, although the relative difference between operational scenarios would be small (i.e., ≤0.2 mg/L). Under Scenario H4, maximum increases of 0.3–0.4 mg/L DOC (i.e., ≤12%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 5). For the operational scenarios, threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Condition comparison, with exception to the drought period predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, and regardless of operational scenario, the frequency which long-term average DOC concentrations exceeded 4 mg/L during the modeled drought period at Buckley Cove would increase from 42% to 50%. While the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to the different components of Operational Scenarios H1–H4 of Alternative 4.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under the four alternative operational scenarios of Alternative 4 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 4 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on operational scenario, baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under all operational scenarios of Alternative 4, relative to Existing Conditions and the No Action Alternative, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants. Modeled decreases would be greatest under Scenarios H2 and H4. Relative to Existing Conditions, long-term average DOC concentrations at Banks under Scenarios H2 and H4 would be predicted to decrease by 0.4 mg/L (0.4 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 5). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Under all the operational scenarios, decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) in particular would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to as much as 83% under Scenario H3, and exceedance of the 4 mg/L concentration threshold would increase slightly for only Scenarios H1 and H3 from 42% to as much as 45%. At the Jones pumping plant, exceedance of the 3 mg/L concentration threshold during the drought period would increase from 72% under Existing Conditions to as much as 93% under Scenario H1, and exceedance of the 4 mg/L threshold would increase slightly for all operational scenarios, from 35% to as much as 41% for Scenario H4. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Depending on operational scenario, long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.4 mg/L. Regardless of operational scenario, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of operations and maintenance activities on DOC under Scenarios H1–H4 of Alternative 4 is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the operational scenarios of Alternative 4 would result in relatively small increases (i.e., ≤14%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. These increases would be greatest for Scenario H4, and least for Scenarios H1, although the difference in change would be relatively small. The predicted increases under the operational scenarios modeled would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Scenarios H1–H4 would generally lead to slightly higher long-term average DOC concentrations (≤0.2–0.5 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 4 Scenarios H1–H4 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative decreases in long-term average DOC concentrations would be greatest under Scenarios H2 and H4, where long-predicted concentrations would decrease as much as 0.4 mg/L at Banks and Jones pumping plants. Regardless of operational scenario, however, slightly more frequent export of >3 mg/L DOC water is predicted during the drought period. Nevertheless, under any operational scenario, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Scenarios H1–H4 of Alternative 4 would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Increases in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be predicted, with the greatest increases occurring under Scenario H4 and the smallest increase occurring under Scenario H1. Under Scenario H4, modeled long-term average DOC concentrations would increase by no more than 0.5 mg/L at any single Delta assessment location (i.e., ≤14% relative increase) while under Scenario H1, modeled long-term DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase). For all operational scenarios considered, the increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** The mostly non-land disturbing CM12–CM21 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–CM21 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measure activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well as highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils. Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 4 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Implementation of CM2, CM3, CM8, CM9, and CM11–CM21 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8, CM9, and CM11–CM21. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

The project proponents will design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, design wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized "hot spots" and net Delta loading.

The project proponents will also establish measures to help guide the design and creation of the target wetland habitats. At a minimum, the measures should limit potential increases in long-term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland and riparian habitat features, consistent with the biological goals and objectives of the BDCP. For example, restoration activities could be designed and located with the goal of preventing, consistent with the biological goals and objectives of the BDCP, net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

However, it must be noted that some of these measures could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, these measures would run directly counter to the goals and objectives of the BDCP. This mitigation measure should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas. As mentioned above, the project proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate, other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to Existing Conditions or the No Action Alternative would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement BMPs for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, none of the operational scenarios of Alternative 4 would be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Pathogens Conceptual Model; Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin

Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total Coliform

- In the Sacramento Valley, the highest total coliform concentrations (>10,000 MPN/100 ml) were located near urban areas.
- Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.
- The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the "appearance" of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

- Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.
- The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.
- *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.
- Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal Coliform

- There was limited data from which to make comparisons/observations.

Cryptosporidium and Giardia

- Data were available only for the Sacramento River, limiting the ability to make comparisons between sources.
- Often not detected and when detected, concentrations typically less than 1 organism per liter.
- There may be natural/artificial barriers/processes that limit *Cryptosporidium* transport to water. Significant die off of those that reach the water may contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the operational scenarios of Alternative 4 relative to Existing Conditions and the No Action Alternative would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

SWP/CVP Export Service Areas

None of the operational scenarios of Alternative 4 are expected to result in substantial changes in pathogen levels in Delta waters, relative to Existing Conditions or the No Action Alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

***NEPA Effects*:** The effects on pathogens from implementing Alternative 4, Scenarios H1–H4, is determined to not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual

Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM11 would involve habitat restoration actions, and CM21 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to the No Action Alternative. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources.

The effects on pathogens from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11 and CM21 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Residues of "legacy" OC pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Regional Water Quality Control Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural storm-water runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Regional Water Quality Control Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Green and Young 2006), although diuron can be found much less frequently in surface waters throughout the year (Johnson et al. 2010).

Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the operational scenarios of Alternative 4, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the operational scenarios of Alternative 4, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito, and the San Joaquin River at Vernalis would change. Relative to Existing Conditions and the No Action Alternative, seasonal average flow rates on the Sacramento for Scenarios H1–H4 would decrease no more than 7% during the summer and 4% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates for Scenarios H1–H4 would decrease no more than 9% during the summer and 2% during the winter, while on the American River average flow rates would decrease by as much as 19% in the summer but would increase by as much as 8% in the winter. Seasonal average flow rates for Scenarios H1–H4 on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 19% are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations under Scenarios H1–H4 of Alternative 4 would not affect these sources.

Under Scenarios H1–H4, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Changes in source water fractions at the modeled Delta assessment locations would vary depending on operational scenario, but relative differences between the operational scenarios would be small. Relative to Existing Conditions, under Scenarios H1–H4 of Alternative 4 modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1, with the largest changes occurring under Scenario H4 (Appendix 8D, *Source Water Fingerprinting Results*). At Buckley Cove under Scenario H4, change in drought period San Joaquin River source water fractions would increase 11% in July and 16% in August. At Franks Tract under Scenario H4, change in San Joaquin River source water fractions when modeled for the 16-year hydrologic period, would increase 11–16% during October through November and February through June. At Rock Slough, modeled San Joaquin River source water fractions under Scenario H4 would increase 15–22% during September through March (11–15% during October and November of the modeled drought period). Similarly, under Scenario H4 modeled San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 15–23% during October through April (12% during October and November of the modeled drought period). While the modeled 22–23% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤29%. For all operational scenarios, relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than 8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions resulting from Scenarios H1–H4 would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions, with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and

August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 4, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases between 16–17% in July (31–34% for the modeled drought period) and 24–25% in August (47–49% for the modeled drought period) (Appendix 8D, *Source Water Fingerprinting Results*). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under all operational scenarios of Alternative 4, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). Sacramento River source water fractions would increase similarly by both season and magnitude extent under all operational scenarios at both Banks and Jones pumping plant. At Banks pumping plant, Sacramento source water fractions would generally increase from 16–48% for the period of January through June (12–35% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 21–56% for the period of January through June (15–48% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects**:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Scenarios H1–H4 of Alternative 4 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment relative to Existing Conditions provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. For all operational scenarios relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities under Scenarios H1–H4 would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Scenarios H1–H4 of Alternative 4, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 4 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding Scenario H1–H4 effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, the considered operational scenarios of Alternative 4 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under Scenarios H1–H4 would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** With the exception of CM13, the mostly non-land disturbing CM12–CM21 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by the CDBW. The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board, USFWS, and NMFS and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

In summary, CM13 of Alternative 4 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could adversely affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

CEQA Conclusion: With the exception of CM13, implementation of CM2–CM21 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected. CM2–CM21 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section

303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, because of the uncertainty about successful implementation of this measure at specific restoration sites programmatic impact is considered significant and unavoidable.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Implement the principals of IPM in the management of invasive aquatic vegetation under CM13, including the selective use of pesticides applied in a manner that minimizes risks to human health, nontarget organisms and the aquatic ecosystem. In doing so, the project proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as selective application of pesticides, timing of applications in order to minimize tidal dispersion, and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may affect phosphorus levels are discussed below.

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: "previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables (Tetra Tech 2006b, Conceptual Model for Organic Carbon in the Central Valley). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006b:4-1 to 4-2). Attempts discussed under Impact WQ-15 also showed weak correlation between nitrate and flows for major source waters to the Delta. The linear regressions between average dissolved ortho-phosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis (Figure 8-57 and Figure 8-58). As expected, neither relationship is very strong, although over the large range in flows for the Sacramento River, the relationship is stronger than for the San Joaquin River. However, over smaller changes in flows, neither relationship can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., <10,000 cfs) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations shown in Figure 8-56, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta under Alternative 4, Scenarios H1–H4, would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

The assessment of effects of phosphorus under Alternative 4, Scenarios H1–H4, in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis. During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations show in Figure 8-56, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

NEPA Effects: In summary, based on the discussion above, effects on phosphorus of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for any operational scenario of Alternative 4, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under the operational scenarios of Alternative 4, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under the various operational scenarios of Alternative 4 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while ortho-phosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–CM21. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM21 is not expected to substantially alter phosphorus concentrations in the affected environment.

The effects on phosphorus from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 under Alternative 4 relative to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected environment, *CM19 Urban Stormwater Treatment*, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds.

Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, Scenarios H1–H4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river and its tributaries. Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative. This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010d) and State Water Board (2010b, 2010c) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, as previously discussed in 8.1.3.15.

Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cfs, as shown in Appendix 8M, *Selenium,* Table M-33 and Figures M-7 through M-20. Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the operational scenarios of Alternative 4.

Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3, *Plan Area*, for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 4, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9b for water, Tables M-14a, through M-14d, and Tables M-24a through M-24d for most biota (whole-body fish (excluding sturgeon)), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59b and 8-60b present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years.

Appendix 8M, Figure M-22 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

All scenarios (H1, H2, H3, and H4) under Alternative 4 would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative at all modeled Delta assessment locations (Appendix 8M, *Selenium*, Table M-9b). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.05 µg/L for the entire period modeled (1976–1991), depending on operational scenario. These small increases in selenium concentrations in water would result in small reductions (4% or less) in available assimilative capacity for selenium, relative to the1.3 µg/L USEPA draft water quality criterion (Figures 8-59b and 8-60b). The long-term average selenium concentrations in water under Alternative 4 Scenarios H1–H4 (range 0.09–0.40 µg/L) would be similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and would all be below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, *Selenium*, Table M-9b).

Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in small changes (approximately 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Tables M-24a through M-24d). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by 14–19% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.6 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by 9–11% in all years (from about 4.4 to 4.9 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31), with the highest percent increase for Scenario H4. Selenium concentrations in sturgeon during drought years are expected to increase by about 3–9% at those locations, with the highest increase in San Joaquin River Antioch in drought years for Scenario H4 (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative) and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 4 would be greater in the East Delta and South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 4 in the South Delta are expected to increase by more than 10 days (Table 8-60a). Relative to the No Action Alternative, annual average residence times for Alternative 4 in the South Delta are expected to increase by less than 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the waterborne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta for most biota (approximately 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 4. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, all scenarios under Alternative 4 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 4 scenarios would result in small (0.05–0.08 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, Table M-9b). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59b and 8-60b). The long-term average selenium concentrations in water for Alternative 4, Scenarios H1–H4 (range 0.16–0.21 μg/L) would be well below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9b).

Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in small changes (approximately 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Tables M-24a through M-24d) at Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative 4 (Figures 8-61a through 8-64b).

NEPA Effects: Selenium concentrations in water and biota very slightly increase progressively from Scenario H1 (smallest) to Scenario H4 (largest). However, based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from all scenarios under Alternative 4 are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 scenarios, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that all scenarios under Alternative 4 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.1 for Alternative 4. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 4 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP. CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, all scenarios under Alternative 4 would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under all Alternative 4 scenarios would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under all scenarios for Alternative 4 would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under these alternative scenarios with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. All scenarios under this alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM21 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

As discussed in Impact WQ-25, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.

The South Delta receives elevated selenium loads from the San Joaquin River, and as Table 8-60a shows, residence times in this area are expected to increase on an annual average by 11 days relative to Existing Conditions, and 9 days relative to the No Action Alternative. However, as discussed in Impact WQ-25, biota concentrations in the South Delta are not approaching levels of concern. Furthermore, in contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic foodweb that includes long-lived sturgeon. The south Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but to a lesser degree than the overbite clam (Lee et al. 2006). Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium. Given the available information, these increases are small enough that they are not expected to cause selenium concentrations in biota in the south Delta to approach or exceed thresholds of concern.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, *Biological Goals and Objectives*). Thus, these areas can be thought of as “flow-through” systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent feasible potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments, AMMs, and CMs,* for a description of the environmental commitment the project proponents are making with respect to Selenium Management; and Appendix 3.C of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

CEQA Conclusion**:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C of the BDCP for more detail on AMM27) also described as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Relative to Existing Conditions and the No Action Alternative, under Alternative 4, Scenarios H1–H4, sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban dry and wet weather runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, *Trace Metals*, Figure 1). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 2). While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N, Tables 1–7). For example, average dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 1.7 μg/L, 2.4 μg/L, and 1.7 μg/L, respectively. The 95th percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 3.4 μg/L, 4.5 μg/L, and 2.4 μg/L, respectively. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment (Tables 8-51 and 8-52). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur under the operational scenario for this alternative.

For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar (Appendix 8N, *Trace Metals*, Tables 8–10). The arsenic criterion was established to protect human health from the effects of long-term chronic exposure, while secondary maximum contaminant levels for iron and manganese were established as reasonable goals for drinking water quality. The primary source water average concentrations for arsenic, iron, and manganese are below these criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur under this alternative.

Relative to Existing Conditions and the No Action Alternative, facilities operation under Alternative 4, Scenarios H1–H4, would result in negligible change in trace metal concentrations throughout the Delta. The operational scenarios of Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

SWP/CVP Export Service Areas

Alternative 4, Scenarios H1–H4, would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under any operational scenario of Alternative 4, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***NEPA Effects*:** In summary, relative to the No Action Alternative, Alternative 4, Scenarios H1–H4, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under any operational scenario of Alternative 4.

The assessment of Alternative 4, Scenarios H1–H4, effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, no operational scenario of Alternative 4 is expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Implementation of CM2–CM21 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in urban stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 4 relative to Existing Conditions and the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 4 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which in turn would alter downstream river flows. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during "first flush events" and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the operational scenarios of Alternative 4 are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta.

Changes in land use that would occur relative to Existing Conditions and the No Action Alternative could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under Alternative 4, Scenarios H1–H4, any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to Existing Conditions or the No Action Alternative. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region. As such, any minor TSS and turbidity changes that may occur under Alternative 4, Scenarios H1–H4, would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The operational scenarios of Alternative 4 are expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4 is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

NEPA Effects: The effects on TSS and turbidity from implementing any operational scenario of Alternative 4 is determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Changes in river flow rate and reservoir storage that would occur under the operational scenarios of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

NEPA Effects: Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under the No Action Alternative.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to the No Action Alternative. The remaining conservation measures would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–CM21 under Alternative 4 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act Section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–CM21, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. The conveyance features for CM1 under Alternative 4 would be very similar to those discussed for Alternative 1A and most of the construction activity would occur in the Delta. The primary difference between Alternative 4 and Alternative 1A is that under Alternative 4, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. Alternative 4 additionally would include construction of an operable barrier at the head of Old River. The remainder of the facilities constructed under Alternative 4, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A. Few, if any, of the CM1–CM21 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: 1) *CM2 Yolo Bypass Fisheries Enhancement* (i.e., the Fremont Weir component of the action), 2) *CM18 Conservation Hatcheries* (i.e., the new hatchery facility), and 3) *CM19 Urban Stormwater Treatment*. Anticipated construction activities that may occur under CM11–CM21, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

Within the Delta, the construction-related activities for Alternative 4 would be most extensive for CM1 involving the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, RTM dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the expanded Clifton Court Forebay, culvert siphon between the northern cell of the expanded Clifton Court Forebay to a new canal to the Jones Pumping Plant and a siphon under the Byron Highway into a short segment of canal leading to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly 4 years to complete.

Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4–CM10 including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, would likely involve a variety of extensive conventional clearing and grading activities on relatively dry sites of the Delta that are currently separated from the Delta channels by levees. Construction would involve new setback levees, excavation and soil placement for new wetland and other habitat feature development, and a variety of potential in-water construction activities such as excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated sediment or dredge material. Construction activities for the proposed restoration sites, due to the direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil and construction-related contaminants, or indirectly through erosion and site inundation during the weeks or months following construction prior to stabilization of newly contoured and restored landforms and colonization by vegetation.

***NEPA Effects*:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM21 under Alternative 4 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Potential construction-related water quality effects may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.

- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce DO levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.

- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.

- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.

- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, and dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury). However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented for Alternative 4 to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 4 would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

Construction-related activities under Alternative 4 would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). The General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required PRDs that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains NALs and for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*), for which Appendix 3B identifies specific BMPs within these categories:

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.

- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.

- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.

- Construction Site Dewatering and Pipeline Testing (BMP category A.8). Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.
- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category "A" BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments, AMMs, and CMs*), BMPs implemented for Alternative 4 also would include the Category "B" BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category "C" BMPs (In-Water Construction BMPs) and Category "D" BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category "E" BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific conservation measures, which as described for the No Action Alternative, may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 4 would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges under the Alternative 4 would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-

term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, with respect to the Existing Conditions and No Action Alternative conditions, Alternative 4 would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 4 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions and the No Action Alternative, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under the four operational scenarios of Alternative 4. Consequently, any modified reservoir operations under any of the four operational scenarios of Alternative 4 are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related changes of water residence times and its effects on *Microcystis* production (i.e., CM1). Other effects of CM2 through CM21 not attributable to hydrodynamics are discussed within the impact header for CM2 through CM21.

Table 8-60a shows modeled long-term average residence times in the six Delta sub-regions during the *Microcystis* summer and fall bloom periods for Existing Conditions, No Action Alternative, and Operational Scenario H3 of Alternative 4. Modeled average residence times for Operational Scenarios H1, H2, and H4 of Alternative 4 are not available. However, during the summer and fall period, the operations and maintenance of Operational Scenarios H3 and H4 are identical, and operations and maintenance of Operational Scenarios H1 and H2 during the summer and fall periods are identical to those of Alternative 3. Thus, the assessment of effects of water residence times on *Microcystis* during the summer and fall bloom periods under Operational Scenarios H1 and H2 of Alternative 4 are based on the assumption that the changes in modeled residence times that would occur under these two operational scenarios would be equivalent to those that would occur under Alternative 3, as shown in Table 8-60a. Likewise, the assessment of effects of water residence times which would occur under Operational Scenario H4 assumes that the changes in modeled residence times that would occur under Operational Scenario H4 would be equivalent to those that would occur under Operational Scenario H3, as shown in Table 8-60a.

Under the four operational scenarios of Alternative 4, modeled long-term average residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through October show varying levels of change, depending on sub-region and timeframe (Table 8-60a). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions, because of climate change and sea level rise, the change is fairly small in most areas of the Delta. Below, residence times under Alternative 4 is compared to residence times under the No Action Alternative to remove the effect of climate change and sea level rise, thereby revealing the effect due to CM1 (i.e., operations) and the effect of the CM2 and CM4 restoration areas, which were accounted for in the modeling performed for CM1.

For Operational Scenarios H1 and H2 of Alternative 4 (as shown for Alternative 3 in Table 8-60a), relative to the No Action Alternative, water residence time is expected to increase 3–10 days in the North Delta (summer and fall); increase 24 days in the summer and decrease 3 days in the fall in the Cache Slough sub-region; increase 6 days in the West Delta (both summer and fall); increase 8 days in the summer and decrease 3 days in the fall in the East Delta; increase 4 days in the summer and decrease 3 days in the fall in the South Delta; and decrease 22 days in the summer and increase 20 days in the fall in the Suisun Marsh sub-region.

For Operational Scenarios H3 and H4 of Alternative 4 (as shown for Alternative 4 in Table 8-60a), relative to the No Action Alternative, water residence time is expected to increase 1–7 days in the North Delta (summer and fall); increase 18 days in the summer and decrease 6 days in the fall in the Cache Slough sub-region; increase 3–4 days in the West Delta (both summer and fall); increase 8–13 days in the East Delta (summer and fall); increase 6 days in the summer and 32 days in the fall in the South Delta; and decrease 23 days in the summer and increase 15 days in the fall in the Suisun Marsh sub-region.

The summer and fall period average residence times provide a general direction in which residence time may change under the four operational scenarios of Alternative 4 compared to the No Action Alternative. The changes in residence time are driven by a number of factors accounted for in the modeling, including the hydrodynamic effects of restoration actions planned under CM2 and CM4, diversion of Sacramento River water at the proposed north Delta intake facility, as well as changes in net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under Alternative 4. However, the expected residence time increases that would occur during the summer bloom period at various Delta locations under the four operational scenarios of Alternative 4, compared to the No Action Alternative, are in a direction and of magnitude that could lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs are discussed in Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley discussed in Appendix 5A, Section D, indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9-4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under Operational Scenarios H1–H4 of Alternative 4, relative to Existing Conditions, but these impacts are due entirely to climate change and not the project alternative. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under Alternative 4, relative to the No Action Alternative.

SWP/CVP Export Service Areas

The assessment of effects from *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under Operational Scenarios H1–H4 of Alternative 4, exports from Banks and Jones pumping plants will consist of a mixture of Sacramento River water diverted around the Delta, with water quality characteristic of both upstream Sacramento River water, and Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water diverted from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the *Delta* section above. Therefore, relative to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the North Delta under Alternative 4 serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether Alternative 4 will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under the four operational scenarios of Alternative 4 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under the four operational scenarios of Alternative 4, relative to Existing Conditions. Conditions in the Export Service Areas under the four operational scenarios of Alternative 4 are not expected to become more conducive to *Microcystis* bloom formation, relative to the No Action Alternative, because neither water residence time nor water temperatures will increase in the Export Service Areas.

NEPA Effects: In summary, operations and maintenance under the four operational scenarios of Alternative 4, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 4 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under the four operational scenarios of Alternative 4, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 4 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2, *Determination of Effects*) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under the various operational scenarios of Alternative 4 additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under any of the operational scenarios of Alternative 4 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under all operational scenarios of Alternative 4, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, residence times are, in general, expected to increase during the *Microcystis* bloom period at various Delta locations under all operational scenarios of Alternative 4. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance under the four operational scenarios of Alternative 4 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under the various operational scenarios of Alternative 4, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 4. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under the four operational scenarios of Alternative 4, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of the four operational scenarios of Alternative 4 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

It remains to be determined whether, or to what degree, *Microcystis* production will increase in Delta areas as a result of increased residence times associated with the implementation of the four operational scenarios of the project alternative. Mitigation actions shall be focused on those incremental effects attributable to implementation of operations under the project alternative only. Development of mitigation actions for the incremental increase in *Microcystis* effects attributable to water temperature and residence time increases driven by climate change and sea level rise is not required because these changed conditions would occur with or without implementation of the project alternative. The goal of specific actions would be to reduce/avoid additional degradation of Delta water quality conditions with respect to occurrences of *Microcystis* blooms.

Additional evaluation will be conducted as part of the development of tidal habitat restoration areas to determine the feasibility of using site placement and design criteria to reduce or eliminate local conditions conducive to *Microcystis* production. Design criteria would be developed to provide guidelines for developing restoration areas to discourage *Microcystis* growth by maintaining adequate flushing, while maintaining the benefits of habitat restoration in terms of zooplankton production, fish food quality, and fish feeding success. For example, a target range of typical summer/fall hydraulic residence time that is long enough to promote phytoplankton growth, but not so long as to promote growth of *Microcystis*, could be used to aid restoration site design. However, currently there is not sufficient scientific certainty to evaluate whether or not longer residence times would result in greater *Microcystis* production, and also whether longer residence times might produce greater benefits to fish and other aquatic life than shorter residence times. This mitigation measure requires that residence time considerations be incorporated into restoration area site design for CM2 and CM4 using best available science at the time of design. It is possible that through these efforts, increases in *Microcystis* attributable to the project alternative, relative to Existing Conditions, could be mitigated. However, there may be instances where this design consideration may not be feasible, and thus, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Because it is not known where, when, and to what extent *Microcystis* will be more abundant under CM1 than under Existing Conditions, specific mitigation measures cannot be described. However, this mitigation measure requires the project proponents to monitor for *Microcystis* abundance in the Delta and use appropriate statistical methods to determine whether increases in abundance are significant. This mitigation measure also requires that if *Microcystis* abundance increases, relative to Existing Conditions, the project proponents will investigate and evaluate measures that could be taken to reduce residence time in the affected areas of the Delta. Operational actions could include timing of temporary or operable barrier openings and closings, reservoir releases, and location of Delta exports (i.e., North Delta vs. South Delta pumping facilities). Depending on the location and severity of the increases, one or more of these actions may be feasible for reducing residence times. If so, these actions could mitigate increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions. However, it is possible that these actions would not be feasible because they would conflict with other project commitments, would cause their own environmental impacts, or would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Impact WQ-33: Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

Implementation of CM3 and CM6–CM21 is unlikely to affect *Microcystis* abundance in the rivers and reservoirs upstream of the Delta, in the Delta region, or the waters exported to the CVP and SWP service areas. Implementation of CM5, Seasonally Inundated Floodplain Restoration, could result in increased local water temperatures in areas near restored seasonally inundated floodplains. However, floodplain inundation typically occurs during spring and winter months when *Microcystis* growth is limited in general by low water temperatures and by insufficient surface water irradiance, and water temperatures would not increase sufficiently due to floodplain inundation such that effects on *Microcystis* growth would occur. Therefore, implementation of CM5 is unlikely to affect *Microcystis* blooms in the project area. Implementation of CM13, Invasive Aquatic Vegetation Control, may increase turbidity and flow velocity, particularly in restored aquatic habitats, which could discourage *Microcystis* growth in these areas. To the extent that IAV removal would affect turbidity and water velocity, it is possible that IAV removal could, to some degree, help offset the increase in *Microcystis* production expected under Alternative 4, relative to the No Action Alternative.

As discussed in detail in Impact WQ-32, development of restoration areas which will occur under CM2 and CM4 could possibly increase the frequency, magnitude, and geographic extent of *Microcystis* blooms due to the hydrodynamic impacts that are expected to increase water residence times throughout various areas of the Delta relative to Existing Conditions and the No Action Alternative. Additionally, restoration activities that create shallow backwater areas, due to implementation of CM2 and CM4, could result in local warmer water that may encourage *Microcystis* growth during the summer bloom forming season and result in further degradation of water quality. Mitigation to specifically address the effects of local increases in water temperatures on *Microcystis* in the vicinity of such restoration areas is not available. Regardless of elevated water temperatures, sufficient residence time is required for *Microcystis* bloom formation. Thus, the combined effect on *Microcystis* from increased local water temperatures and increased water residence times may be reduced by implementation of Mitigation Measure WQ-32a. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain.

NEPA Effects: Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be adverse.

CEQA Conclusions: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 4.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 4 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 4 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely affect any beneficial uses of San Francisco Bay.

The effects of Alternative 4 on EC in the Delta were determined to be significant/adverse. Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. However, potential effects on bay salinity are discussed further below, with consideration to effects on fish and wildlife beneficial uses.

While effects of Alternative 4 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Because the potential change in *Microcystis* levels were found to be significant in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San Francisco Bay are discussed. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 4 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 24–28%, relative to Existing Conditions, and increase by 5–12%, relative to the No Action Alternative, depending on operations scenario (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 4 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 4 is estimated to increase by -1–+5%, relative to Existing Conditions and increase by 0–6% relative to the No Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 4. Mercury load to the Bay is estimated to increase by 1–5 kg/year (<1–2%), relative to Existing Conditions, and to increase by -2–+2kg/year (-1–+1%), relative to the No Action Alternative, depending on operations scenario. Methylmercury load is estimated to increase by 0–0.13 kg/year (0–4%), relative to Existing Conditions, and increase by -0.09–+0.04 kg/year (-2–+1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 261–265 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 4 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Salinity

Salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the alternative could affect salinity in San Francisco Bay. According to the Delta Atlas (California Department of Water Resources 1995), average historical tidal flow through the Golden Gate Bridge is 2,300,000 cfs and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow due to the No Action Alternative (shown in Appendix 5A, Section C.7). Thus, the changes in Delta outflow due to Alternative 4 would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 4, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 6–11%, relative to Existing Conditions, and increase by 2–8%, relative to the No Action Alternative, depending on operations scenario (Appendix 8O, *San Francisco Bay Analysis*, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 4, the long-term average total selenium concentration of the North Bay is estimated to be 0.013–0.14 μg/L and the dissolved selenium concentration is estimated to be 0.12 μg/L, which would be 0.01 μg/L higher than Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 4 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

Microcystis

Microcystis has not been detected in embayments of the San Francisco Bay downstream of Suisun Bay. Low levels of microcystins occur throughout San Francisco Bay, but their concentrations do not correspond to *Microcystis* abundance, nor is there evidence that they have been transported downstream from *Microcystis* blooms that have occurred in the Delta (Senn and Novick 2013). The low levels of microcystins present in San Francisco Bay are likely derived from cyanobacteria besides *Microcystis*, such as *Cyanobium sp.* and *Synechocystis*, which are currently resident in the San Francisco Bay at levels well below bloom magnitude (Senn and Novick 2013). Elevated microcystin levels could occur at various locations in the Delta during *Microcystis* blooms under Alternative 4, but because of the sufficient dilution available in San Francisco Bay, downstream transport of Delta-derived microcystins are not expected to result in measurable changes in the microcystin levels of San Francisco Bay.

The absence of *Microcystis* in San Francisco Bay is likely directly related to its intolerance of elevated salinity, as its growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities of this magnitude for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow. However, high Delta outflows occur during wet years and during the winter and spring runoff season, under which water temperatures are expected to be low, turbidity high, and water residence times low, making the environment of San Pablo Bay unsuitable for *Microcystis* growth. Additionally, these hydrodynamics conditions typically only occur when the potential for *Microcystis* blooms to occur upstream of, and thus potentially seed *Microcystis* to, San Pablo Bay are minimal. Alternative 4 is not expected to result in significant modification to net Delta outflows or the timing of high outflow events related to wet season runoff. Thus, the effects of Alternative 4 on *Microcystis* levels in San Francisco Bay are expected to be negligible.

NEPA Effects: Based on the discussion above, Alternative 4, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 4 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents' levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 24–28% decrease in total nitrogen load and -1–+5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (1–5 kg/year; <1–2%) and methylmercury load (0.00–0.13 kg/year; 0–4%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 6–11%, but estimated total and dissolved selenium concentrations under this alternative would be nearly the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.10 Alternative 5—Dual Conveyance with Pipeline/Tunnel and Intake 1 (3,000 cfs; Operational Scenario C)

Alternative 5 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 5 would convey up to 3,000 cfs of water from the north Delta to the south Delta. Diverted water would be conveyed through pipelines/tunnels from a single screened intake (i.e., Intake 1) located on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 5 would include a 750-acre intermediate forebay and pumping plant. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario C, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A with the exception of CM4, which would involve 25,000 acres of tidal habitat restoration instead of 65,000 acres under the other BDCP alternatives. See Chapter 3, *Description of Alternatives*, Section 3.5.10, for additional details on Alternative 5.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 5, over the long term, average annual delta exports are anticipated to decrease by 358 TAF relative to Existing Conditions, and increase by 346 TAF relative to the No Action Alternative. Because, over the long-term, approximately 25% of the exported water would be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this would be increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 5–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 5, long-term average annual Delta outflow is anticipated to increase 401 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). Long-term average annual Delta outflow is anticipated to decrease under Alternative 5 by 349 TAF relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increases in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 5–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 5 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-68 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 5 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, August, September, November, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 5, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 5 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 5, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-68. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 5

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 5	0.072	0.088	0.070	0.061	0.058	0.061	0.058	0.064	0.064	0.060	0.070	0.067	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 5 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 5, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects**:** In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 5, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 5, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on ammonia under Alternative 5 would be the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 5 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin

River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 5 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, *Boron*, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 5 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Effects of CM1 on boron under Alternative 5 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 5 would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 7% at the SF Mokelumne River at Staten Island, 2% at the San Joaquin River at Buckley Cove, 8% at Franks Tract, and 7% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-14). This comparison to Existing Conditions reflects changes due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, *Boron*, Table Bo-15). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 5, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 5 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 5, long-term average boron concentrations would decrease by as much as 11% at the Banks Pumping Plant and Jones Pumping Plant relative to the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-14) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 5 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 5 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response (i.e., up to 8% increase) to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 5 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to

Existing Conditions, Alternative 5 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 5 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on boron under Alternative 5 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 5 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 5 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 5 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 5, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 5, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 5, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 12). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 µg/L to 63 µg/L (23% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 98 µg/L (84% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 5, but would increase from 55% to 68% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 18% under Alternative 5, and would increase from 0% to 38% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 67% under Alternative 5 (52% to 77% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 2% under Alternative 5 (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 59 µg/L (62 µg/L for the modeled drought period) at Staten Island under Alternative 5. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative would be generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 12). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by 27% (83% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove, Rock Slough, and Contra Costa PP No. 1 would increase relative to No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 5 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 12). Such similarity demonstrates that the modeled Alternative 5 change in bromide is almost entirely due to Alternative 5 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 5 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 13). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 5, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 20% under Alternative 5.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 5 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 128 μg/L (25% increase) at City of Antioch and would increase from 150 μg/L to 194 μg/L (30% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 5, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 30% relative to Existing Conditions and 20% relative to No Action Alternative. Relative change in long-term average bromide concentration would be less during drought conditions (≤27%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 12). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 13).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 5 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 5 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 5 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 5 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 5, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 5 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 5, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 30% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 5 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 5, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 5 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 23%, and 84% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 18% under Alternative 5, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** CM2–CM21 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 acres rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A, implementation of the CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 5, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A, except that 25,000 acres rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A, implementation of the CM2–CM21 (CM2–CM21) would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 5 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-62). Consequently, Alternative 5 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤18%), Sacramento River at Emmaton (i.e., ≤3%), and SF Mokelumne at Staten Island (i.e., ≤16%) (Appendix 8G, *Chloride*, Table Cl-31 and Table Cl-32). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at four of the assessment locations. Chloride concentrations would increase at the SF Mokelumne River at Staten Island (up to 19%) and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative conditions and increase only incrementally (3% or less) at five other stations (Appendix 8G, *Chloride*, Table Cl-31). The comparison to the No Action Alternative reflects changes in chloride due only to operations.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 5, the modeled frequency of objective exceedance would remain unchanged at 7% of years under Existing Conditions and Alternative 5 (Appendix 8G, *Chloride*, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 5, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 5 (Appendix 8G, *Chloride*, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride*, Table Cl-33 and Figure Cl-9). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 72%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-33), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 45% of assimilative capacity for the 16-

year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-35 and Figure Cl-9).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Table Cl-34 and Table Cl-36). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of the 250 mg/L Bay Delta WQCP objectives for chloride, and magnitude of associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at the Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12). Although modeling of Alternative 5 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 5, the modeled frequency of objective exceedance would increase from 0% under the No Action Alternative to 7% of years under Alternative 5 (Appendix 8G, *Chloride*, Table Cl-64). The increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 6 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. For Alternative 5, the modeled frequency of objective exceedance would decrease slightly from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 5 (Appendix 8G, *Chloride*, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small decrease in exceedance frequency would be predicted at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 72%), however, available assimilative capacity would be reduced in April (i.e., up to 10% for the 16 year period modeled, and 100% [i.e., eliminated] for the drought period modeled) (Appendix 8G, *Chloride*, Table Cl-35). The exceedance frequency would increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to 87%) and at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 18%) (Appendix 8G, Table Cl-33), along with reduced assimilative capacity at the Contra Costa Canal at Pumping Plant #1 in September (i.e., up to 56%), reflecting substantial degradation during when average concentrations would be near, or exceed, the objective (Appendix 8G, Table Cl-35).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Table Cl-34 and Table Cl-36). However, as with Alternative 1A, the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of the 250 mg/L Bay Delta WQCP objectives for chloride, and the associated long-term average water quality degradation at interior and western Delta locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, Alternative 5 would generally result in changes similar to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis, based on results for Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta (Appendix 8G, Figure Cl-10).

Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, *Chloride*, Figures Cl-9, Cl-11, and Cl-12) would increase substantially in some months during October through May compared to the No Action Alternative conditions, but sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 5, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 29% relative to Existing Conditions and 19% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-31). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-33). Consequently, water exported to the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, *Chloride*, Table Cl-32 and Table Cl-34).

Commensurate with the reduced chloride concentrations in water exported to the SWP/CVP service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 5 would result in increased water quality degradation and frequency of exceedance of the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and could contribute to measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 5 would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 5 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 5 would result in substantially increased chloride concentrations in the Delta such that frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 6%) and at Mallard Slough (by 2%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 5 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Under Alternative 5, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 5 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on DO under Alternative 5 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

Reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 5, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on DO under Alternative 5 would e the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 5 are not expected to be outside the ranges occurring under Existing Conditions or that would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 5 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 5 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point and Prisoners Point, and Old River at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-5).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 25% under Alternative 5, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 38% under Alternative 5.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 5% under Alternative 5, and the percentage of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 9% under Alternative 5. Sensitivity analyses were performed for Alternative 4 Scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and

CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percentage of days the Jersey Point fish and wildlife EC objective would be exceeded and the percentage of days out of compliance for the entire period modeled would increase from 0% under Existing Conditions to 3% under Alternative 5. The percentage of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 8% under Alternative 5, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 12% under Alternative 5. These changes are very small, and are likely within the uncertainty of the modeling approach. Nevertheless, further discussion of EC increases relative to this objective can be found in Appendix 8H, Attachment 2.

In Old River at Tracy Bridge, the percentage of days exceeding the EC objective would increase from 4% under Existing Conditions to 5% under Alternative 5; the percentage of days out of compliance would increase by <1% and would be 10% under both Existing Conditions and Alternative 5. These changes are minimal, but, regardless, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at this location, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 2–35% for the entire period modeled and 3–32% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-16). At Emmaton, average EC would increase by 3% for the entire period modeled and 10% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 3% for the entire and drought periods modeled; and San Joaquin River at San Andreas Landing average EC would increase 5% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during February through August. Average EC would increase at San Andreas Landing from January through September. Average EC in the S. Fork Mokelumne River at Terminous would increase from March through December (Appendix 8H, Table EC-16). The comparison to Existing Conditions reflects changes in EC due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-5). The increase in percentage of days exceeding the EC objective would be 11% at Emmaton and 7% or less at the remaining locations. The increase in percentage of days out of compliance would be 13% at Emmaton and 11% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: Sacramento River at Emmaton (2%), S. Fork Mokelumne River (4%), San Joaquin River at San Andreas Landing (10%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-16). During the drought period modeled, average EC would increase at these same locations, except at Emmaton, by a similar percentage as well as the San Joaquin River at Brandt Bridge (1%). The comparison to the No Action Alternative reflects changes in EC due only to Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 5, relative to Existing Conditions, during the months of March through May by 0.4–0.6 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6–5.0 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.9–2.8 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 5 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased EC that could occur in the western Delta, relative to Existing Conditions and the No Action Alternative could lead to water quality degradation that would make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 5 would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 5.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 5 would decrease 19% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 13% for the entire period modeled and 12% during the drought period modeled. (Appendix 8H, *Electrical Conductivity*, Table EC-16)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 5 would decrease 15% for the entire period modeled and 16% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 11% for the entire period modeled and 12% during the drought period modeled. (Appendix 8H, *Electrical Conductivity*, Table EC-16).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 5 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 5 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 5 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

***NEPA Effects*:** In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under Alternative 5, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Given that the western is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh could further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate other commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 5 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 5 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 19%; increase) and at Jersety Point (fish and wildlife objective, 3%), and the San Joaquin River at Prisoners Point (fish and wildlife objective; 2% increase) in the interior Delta. Further, long-term average EC levels would increase in the Sacramento River at Emmaton by 3% for the entire period modeled and 10% during the drought period modeled, and in the San Joaquin River at San Andreas Landing by 5% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton, and the increased long-term and drought period average EC levels in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the western and interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Jersey Point and Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 5 could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on EC under Alternative 5 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 5, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 5 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 5.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 5 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.9% at Old River at Rock Slough and the Contra Costa Pumping Plant, and 0.9% at Franks Tract relative to the No Action Alternative (Figures 8-53a and 8-54a). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I, *Mercury*, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest change in exceedance quotients of 6–8% is expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and 7% for the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figures 8-55a and8-55b; Appendix 8I, *Mercury*, Table I-12b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 5 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, *Mercury*, Figures I-6 and I-7). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a). Bass tissue mercury concentrations are also improved under Alternative 5, relative to Existing Conditions and the No Action Alternative (Figure 8-55a and 8-55b; Appendix 8I, *Mercury*, Tables I-12a and I-12b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 5 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 5, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing

Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 5 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 5 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 5 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities under Alternative 5 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 5 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 5 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 5.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 5 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 5, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 5.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 19 and 20). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 5, relative to Existing Conditions, and slightly increased relative to the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 5.6% use of assimilative capacity available under the No Action Alternative, for the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 21).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 5, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 5, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 5, the increase is expected to be greater under Existing Conditions than for Alternative 5 due to the upgrades that are assumed under Alternative 5.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Tables 19 and 20). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, *Nitrate*, Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Appendix 8J, *Nitrate*, Table 21).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on nitrate under Alternative 5 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 5, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 5, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 5, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be distributed differently. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2–0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, *Organic Carbon,* DOC Table 6). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 64% under the Alternative 5 (an increase from 47% to 62% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 32% (32% to 37% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 70% under Alternative 5 (45% to 75% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 35% (35% to 40% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 5 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other components of Operational Scenario C) and climate change/sea level rise.

In comparison, Alternative 5 relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.1–0.2 mg/L DOC (i.e., ≤6%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 6). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 31% (42% to 53% for the modeled drought period). While the Alternative 5 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 5 operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 5 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 5 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 5, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for the modeled 16-year hydrologic period, relative to Existing Conditions and No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 6). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L, but be predicted to increase by 0.1 mg/L for the modeled drought period. Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under Existing Conditions to 69% under Alternative 5 (57% to 83% for the drought period), and at Jones would increase from 71% to 78% (72% to 93% for the drought period). Relative to the 4 mg/L concentration threshold, long-term average DOC concentrations at Banks would decrease from 33% under Existing Conditions to 27% under Alternative 5, but would increase slightly from 42% to 44% for the modeled drought period. At Jones, concentrations exceeding 4 mg/L would increase slightly from 26% to 27% (35% to 39% for the drought period). Frequency of exceedance comparisons to the No Action Alternative yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict a slight long-term improvement in Export Service Areas water quality respective to DOC. This improvement is principally obtained through overall lower long-term average DOC concentrations at Banks and Jones.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***NEPA Effects*:** In summary, Alternative 5, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.3 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.2 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 5 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 5 would result in relatively small increases (i.e., ≤8%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 5 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 5 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 0.3 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 5 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 acres rather than 65,000 acres of tidal habitat would be restored. Effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A, except that the reduced acreage of proposed tidal habitat would reduce the overall Alternative 5-related DOC loading to the Delta. While this reduced acreage would result in reduced DOC loading relative to other action alternatives, CM4–CM7 and CM10 could still contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 5 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 5 would be similar to those discussed for Alternative 1A, although the overall magnitude of effect is expected to be less due to the smaller acreage proposed for tidal habitat restoration. Regardless of the smaller proposed acreage, these restoration activities could present a substantial source of DOC loading to the Delta. Similar to Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 5 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 5 would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on pathogens under Alternative 5 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 5 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 5, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 4% during the summer, but would increase by as much as 5% in the winter. American River average flow rates would decrease by as much as 15% in the summer and 1% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 5, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction was evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 5 modeled San Joaquin River fractions would increase greater than 10% (excluding Banks and Jones pumping plants) at Rock Slough and Contra Costa PP No. 1 (Appendix 8D, *Source Water Fingerprinting Results*). At Rock Slough, modeled San Joaquin River source water fractions would increase 16% during November (13% for the modeled drought period), while at Contra Costa PP No. 1 San Joaquin River source water fractions would increase 15% during November and 12% during March. Corresponding increases for the modeled drought period would not be greater than 8% at Contra Costa PP No. 1. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under Alternative 5, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 12% in July (25% for the modeled drought period) and 22% in August (43% for the modeled drought period) (Appendix 8D, *Source Water Fingerprinting Results*). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 5, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 14–28% for March through June (17% for April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 12–24% for January through June (15–27% for March through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 5 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 5, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 5 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 5 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** CM2–CM21 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 acres rather than 65,000 acres of tidal habitat would be restored. As such, effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A, except that the likely overall use of herbicides to control invasive aquatic vegetation would likely be reduced commensurate with the reduction in restored acres of tidal habitat. Nevertheless, herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion**:** Effects of CM2–CM21 on pesticides under Alternative 5 are similar to conservation measures discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 5, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 5, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 5, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 5 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 5, which are considered to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 5, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-15 and M-25 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-23 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 5 would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.02 µg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (1–2% or less) in available assimilative capacity for selenium, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 5 (range 0.09–0.39 µg/L) would be similar to those for Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and would be well below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, *Selenium*, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-25). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 7% relative to Existing Conditions and the No Action Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 4% in all years (from about 4.4 to 4.6 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2–5% at those locations (Appendix 8M, Tables M-30 and M-

31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative); however, for the entire period modeled, the quotient would not be exceeded at either location (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on “fixed” K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 5 would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 5 in the East Delta are expected to increase by more than 16 days (Table 8-60a). Relative to the No Action Alternative, annual average residence times for Alternative 5 in the East Delta are expected to increase by less than 9 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions, and 3 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below,

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 5 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 5 would result in small decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium of 2–4%. Furthermore, the long-term average selenium concentrations in water for Alternative 5 (range 0.19–0.25 μg/L) would be well below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet] bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-25) at Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative 5 (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 5 are not considered to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 5 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.0 for Alternative 5. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 5 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 5 would cause no increase in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 5 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions and the No Action Alternative, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 5 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 5 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 5, relative to Existing Conditions and the No Action Alternative. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***NEPA Effects*:** In summary, Alternative 5, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 5 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95^{th} percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95^{th} percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 5.

The assessment of the Alternative 5 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 5 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 acres rather than 65,000 acres of tidal habitat would be restored. Effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 5, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 5 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 5 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 5, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on TSS and turbidity under Alternative 5 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 5 would be similar to conservation measures proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The conveyance features for CM1 under Alternative 5 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 5 and Alternative 1A is that under Alternative 5, there would be four fewer intakes and four fewer pumping plant locations, which would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 5, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 5, there would only be up to 25,000 acres of tidal marsh habitat restored (as opposed to 65,000 acres under the majority of the other alternatives), thus resulting in less in-water construction-related disturbances.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1–CM21 under Alternative 5 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. However, the construction of fewer intakes and smaller conveyance features for CM1, and less tidal marsh habitat restoration, under Alternative 5 would be anticipated to result in a lower magnitude of construction-related activities. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 5 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 5 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 5 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 5, relative to Existing

Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 5 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 5, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 5, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 5 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 5 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 5 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 5 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 5, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 5 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 5, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 5 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 5, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 5. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 5, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 5. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 5, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 5 would be the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 5 would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 5 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 5 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 5 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 5 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 31%, relative to Existing Conditions, and increase by 2%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 5 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 5 is estimated to increase by 3%, relative to Existing Conditions, and decrease by 2% relative to the No Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 5. Mercury load to the Bay is estimated to increase by 3 kg/year (1%), relative to Existing Conditions, and be unchanged relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.06 kg/year (2%), relative to Existing Conditions, and decrease by 0.03 kg/year (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 263 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 5 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 5, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 4%, relative to Existing Conditions, and increase by 1%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 5, the long-term average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 5 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 5, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 5 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the

Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31% decrease in total nitrogen load and 3% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (3 kg/year; 1%) and methylmercury load (0.06 kg/year; 2%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 4%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.11 Alternative 6A—Isolated Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6A would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 6A would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes (i.e., Intakes 1 through 5) on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 6A would include a 750-acre intermediate forebay and pumping plant. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. However, this. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.11, for additional details on Alternative 6A.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.

- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

The primary differences between Alternative 6A and Alternative 1A are that all of the Delta exports would be via the north Delta diversion intakes, with none through the existing south Delta intakes, and operations include the meeting of Fall X2.

Under Alternative 6A, over the long term, average annual delta exports are anticipated to decrease by 1,386 TAF relative to Existing Conditions, and by 682 TAF relative to the No Action Alternative. All of the exported water will be from the new north Delta intakes, and none of the diversions would be from the existing south Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is greatly increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 6–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 6A, long-term average annual Delta outflow is anticipated to increase 1,383 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this would be decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 6A would be greater relative to Existing Conditions because Existing Conditions do not include operations to meet Fall X2, whereas the No Action Alternative and Alternative 6A do. Long-term average annual Delta outflow is anticipated to increase under Alternative 6A by 633 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 6A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 6A is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-69 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 6A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through April, and July through December, and remaining months would be unchanged. A minor increase in the annual average concentration would occur under Alternative 6A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 6A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 6A, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-69. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 6A

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 6A	0.075	0.086	0.070	0.061	0.058	0.061	0.059	0.064	0.067	0.062	0.068	0.066	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 6A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with diversion of water not influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 6A, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***NEPA Effects*:** In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 6A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 6A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on ammonia under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 6A in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 6A operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to Existing Conditions (Appendix 8F, *Boron*, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 6A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 6A would result in generally widespread increased long-term average boron concentrations for the 16-year period modeled at the interior and western Delta locations (by as much as 14% at the SF Mokelumne River at Staten Island, 4% at the San Joaquin River at Buckley Cove, 43% at Franks Tract, and 74% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-16). The comparison to Existing Conditions reflects changes due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 21% at Franks Tract and up to 43% at Old River at Rock Slough locations (Appendix 8F, *Boron*, Table Bo-17). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 6A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 6A in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 6A, long-term average boron concentrations would decrease by as much as 56% at the Banks Pumping Plant and by as much 63% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-16) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 6 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 6, relative to

Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 6A would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 75% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 6A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 6A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 6A, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 6A would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on boron under Alternative 6A would be the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 6A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 6A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 6A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 6A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 6A, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 6A would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 14). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 μg/L to 61 μg/L (19% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 92 μg/L (73% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 6A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 6A, and would increase from 0% to 37% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 μg/L to 70 μg/L (41% relative increase) for the modeled 16-year hydrologic period and would increase from 51 μg/L to 70 μg/L (37% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 μg/l threshold exceedance, from 47% under Existing Conditions to 85% under Alternative 6A (52% to 88% for the modeled drought period), and an increase from 1% to 10% (0% to 5% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative would be generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 14). Modeled long-term average bromide concentration increases at Barker Slough are predicted to increase by 22% (72% for the modeled drought period) relative to the No Action Alternative.

Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 45% (41% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 6A operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 14). Such similarity demonstrates that the modeled Alternative 6A change in bromide is almost entirely due to Alternative 6A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 6A is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 15). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 6% exceedance over the modeled period under Alternative 6A, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 17% under Alternative 6A. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard

Slough and City of Antioch under Alternative 6A would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 162 μg/L (58% increase) at City of Antioch and would increase from 150 μg/L to 199 μg/L (33% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 6A would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 41–61%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 6A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 96% relative to Existing Conditions and the No Action Alternative (Appendix 8E, *Bromide*, Table 14). As a result, exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be completely eliminated, resulting in considerable overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San

Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 15).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, Alternative 6A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 6A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects. Implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 6A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 6A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 6A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 6A would result in substantial increases in long-term average bromide concentration at Barker Slough and Staten Island. There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 6A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 96% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 6A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 6A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 6A operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 19%, and 73% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to 17% under Alternative 6A, while for the modeled drought period, the frequency would increase from 0% to 37%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 6A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 6A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-62). Consequently, Alternative 6A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, the predicted long-term average chloride concentrations under Alternative 6A for the 16-year period modeled would be substantially reduced at most of the assessment locations (Appendix 8G, *Chloride*, Table Cl-37 and Table Cl-38). Moreover, the direction and magnitude of predicted changes for Alternative 6A are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Depending on the modeling approach (see Section 8.3.1.3), the average chloride concentrations would be increased at the North Bay Aqueduct at Barker Slough (i.e., ≤15%) and SF Mokelumne at Staten Island (i.e., ≤37%). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 6A, the modeled frequency of objective exceedance would remain unchanged at 7% of years under Existing Conditions and Alternative 6A (Appendix 8G, *Chloride*, Table Cl-64). The modeled frequency of objective exceedance would increase from 0% of years under the No Action Alternative to 7% under Alternative 6A. However, the increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 9 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 6A, the modeled frequency of objective exceedance would be eliminated, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 0% of modeled days under Alternative 6A (Appendix 8G, *Chloride*, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for Existing Conditions to 0% for Alternative 6A), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Chloride, Table Cl-39 and Figure Cl-9). The frequency of exceedances at the San Joaquin River at Antioch also would decrease compared to all of the alternative scenarios (i.e., 9% from 66% for Existing Conditions to 57%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-39). However, available assimilative capacity would be reduced relative to Existing Conditions in April (i.e., up to 21%) (Appendix 8G, Table Cl-41) reflecting substantial degradation during a month when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, *Chloride*, Table Cl-40 and Table Cl-42). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June. (i.e., maximum of 81% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would generally be similar compared to Existing Conditions and No Action Alternative, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12), Although modeling of Alternative 6A assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 6A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by approximately 95% relative to Existing Conditions and No Action Alternative (Appendix 8G, *Chloride*, Table Cl-37). The modeled low-frequency exceedances of objectives present under the Existing Conditions and No Action Alternative would be eliminated under Alternative 6A (Appendix 8G, *Chloride*, Table Cl-39). Consequently, water exported into the SWP/CVP service area would generally be improved with regards to chloride relative to Existing Conditions and No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, *Chloride*, Table Cl-38 and Table Cl-40).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 6A would result in substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Antioch, and Rock Slough, and could result in increased concentrations with respect to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 6A would contribute substantially to the adverse water quality effects.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 6A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 6A operations would result in substantially reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects on the municipal and industrial beneficial uses at these locations (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be significant due to increased degradation relative to the 250 mg/L objective in the western Delta as well as potential increased degradation relative to the 303(d) listing in Suisun Marsh.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 6A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation in Suisun Marsh and its effects on fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Under Alternative 6A, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 6A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on DO under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

Reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 6A, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on DO under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 6A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 6A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 6A would result in an increase in the number of days the Bay-Delta WQCP EC objectives for fish and wildlife protection (which apply during April and May in all but critical water year types) would be exceeded in the San Joaquin River at Jersey Point and Prisoners Point (Appendix 8H, *Electrical Conductivity*, Table EC-6), and an increase in exceedance of the agricultural EC objective for the Sacramento River at Emmaton.

The percentage of days the fish and wildlife EC objective would be exceeded at Jersey Point for the entire period modeled (1976–1991) would increase from 0% under Existing Conditions to 3% under Alternative 6A, and the percentage of days out of compliance with the EC objective would increase from 0% under Existing Conditions to 5% under Alternative 6A. The percentage of days the EC objective would be exceeded at Prisoners Point for the entire period modeled would increase from 6% under Existing Conditions to 40% under Alternative 6A, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 40% under Alternative 6A. Sensitivity analyses conducted for Alternative 4 Scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

At Emmaton, the percentage of days the EC objective would be exceeded would increase from 6% under Existing Conditions to 32% under Alternative 6A, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 44% under Alternative 6A.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 2–56% for the entire period modeled and 3–52% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-17). In the S. Fork Mokelumne River at Terminous, average EC would increase 7% for the entire period modeled and 6% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous (an interior Delta location) would increase during all months (Appendix 8H, Table EC-17). The western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC and there would be an increased exceedance of the EC objective at Emmaton. Thus, relative to Existing Conditions, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The comparison to Existing Conditions reflects changes in EC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percentage compliance with Bay-Delta WQCP EC objectives under Alternative 6A would be similar to that described above relative to Existing Conditions for the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point and Prisoners Point. In addition, there would also be a slight increase (<1%) in the percentage of days the EC objective would be exceeded in Old River at Tracy Bridge for the entire period modeled. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River at Terminous; San Joaquin River at Brandt Bridge and Prisoners Point; and Old River at Tracy Bridge. The greatest average EC increase would occur in the S. Fork Mokelumne River at Terminous (8%); the average EC increase at the other locations would be <1–3% (Appendix 8H, *Electrical Conductivity*, Table EC-17). During the drought period modeled, average EC would increase at the same locations, except San Joaquin River at Prisoners Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (7%); the increase at the other locations would be 1–2% (Appendix 8H, Table EC-17). Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives at Emmaton, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 6A, relative to Existing Conditions, during the months of April and May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–2.2 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 0.4–1.7 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 6A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 6A would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 6A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 6A would decrease substantially on average: 67% for the entire period modeled and 73% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 64% for the entire period modeled and 71% during the drought period modeled. (Appendix 8H, Table EC-17)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 6A would also decrease substantially: 68% for the entire period modeled and 74% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 67% for the entire period modeled and 73% during the drought period modeled. (Appendix 8H, Table EC-17)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 6A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 6A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 6A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives in the western Delta under Alternative 6A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point and Jersey Point EC objectives and long-term and drought period average EC at Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects. Iimplementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 6A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Alternative 6A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for fish and wildlife protection are exceeded in the San Joaquin River at Jersey Point (from 0% under Existing Conditions to 3% under Alternative 6A) and Prisoners Point (from 6% under Existing Conditions to 40% under Alternative 6A), and an increase in the EC agricultural objectives at Emmaton for the entire period modeled (1976–1991). Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. Portions of the Delta on the Clean Water Act section 303(d) list as impaired due to elevated EC would not have increased long-term average EC levels relative to Existing Conditions, However, at Emmaton, which is in the western Delta, there would be an increased frequency of exceedance of the EC objective. Thus, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The increased frequency of exceedance of fish and wildlife EC objectives at Prisoners Point and Jersey Point could adversely affect aquatic life beneficial uses specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 6A could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments,* *AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on EC under Alternative 6A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under the Alternative 6A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 6A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 6A.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 6A relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 9.2% at the Contra Costa Pumping Plant, 9.1% at the Contra Costa Pumping Plant relative to the No Action Alternative (Figures 8-53a and 8-54a). These changes are not expected to result in adverse effects to beneficial use. Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest increases in exceedance quotients (ranging from 33 to 64%) are expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and the No Action Alternative (Figure 8-55a and 8-55b; Appendix 8I, Table I-13b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 6A are projected to be lower than Existing Conditions and the No Action Alternative (Appendix 8I, *Mercury*, Figures I-4 and I-5). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 6A, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 41% improvement relative to Existing Conditions, 43% relative to the No Action Alternative) (Figures 8-55a and 8-55b; Appendix 8I, *Mercury*, Table I-13b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 6A to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 6A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for Alternative 6A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 6A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 6A would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Some habitat restoration activities under Alternative 6A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 6A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 6A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 6A.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 6A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 6A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 6A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to

the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 22 and 23). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to 0.78, 1.23 and 1.33 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Appendix 8D, *Source Water Fingerprinting Results*). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 14% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 8–9% on a long-term average basis (Appendix 8J, Table 24). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 7%, and averaged 3–4% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%), except San Joaquin River at Buckley Cove in August, which showed a 7.3% use of the assimilative capacity that was available under the No Action Alternative, for the drought period (1987–1991) (Appendix 8J, Table 24).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 6A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 6A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial

dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 6A, the increase is expected to be greater under Existing Conditions than for Alternative 6A due to the upgrades that are assumed under Alternative 6A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis, and on an average monthly basis for every month of the year (Appendix 8J, *Nitrate*, Tables 22 and 23). No additional exceedances of the MCL are anticipated (Appendix 8J, Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, there was no use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, for both Banks and Jones pumping plants (Appendix 8J, Table 24).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***NEPA Effects*:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was not of sufficient magnitude to increase the risk of substantially effecting beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated, and there was no use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants for all months.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on nitrate under Alternative 6A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 6A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 6A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 6A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 1.0–1.6 mg/L would be predicted (≤46% net increase) resulting in long-term average DOC concentrations greater than 4 mg/L at all three Delta interior locations (Appendix 8K, *Organic Carbon,* DOC Table 7). Long-term average increases of 0.2–0.6 mg/L (≤20% net increase) would also occur at Staten Island, Emmaton, Antioch and Mallard Island. Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under the Alternative 6A (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 79% (32% to 95% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under Alternative 6A (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 84% (35% to 95% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other components of Operational Scenario D) and climate change/sea level rise.

In comparison, Alternative 6A relative to the No Action Alternative N would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 1.0 to 1.5 mg/L DOC (i.e., ≤41%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to the No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 7). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 30% (42% to 53% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 6A operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 6A, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 6A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease approximately 0.1 mg/L (including the drought period), depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 6A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 7). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 39% under Alternative 6A (100% to 33% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 6A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.5 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 6A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 6A would result in substantial increases (i.e., 1.0–1.6 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 6A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 1.8 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤10% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 6A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 6A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 6A would result in a substantial increase in long-term average DOC concentrations (i.e., 1.0–1.6 mg/L, equivalent to ≤46% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 6A, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and therefore implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

To reduce the effect of CM1 operations on increased DOC concentrations specifically predicted to occur at municipal water purveyors obtaining raw source water through south Delta intakes at Rock Slough and those associated with Contra Costa PP No. 1, the BDCP proponents shall consult with the purveyors (i.e., Contra Costa water district and entities to which they supply raw water) to identify the means to either avoid, minimize, or offset increases in long-term average DOC concentrations that affect the beneficial use of the water. The BDCP proponents shall consult with these entities to determine existing DBP concentrations (as system-wide running averages), and then implement any combination of measures sufficient to maintaining these concentrations at existing levels in treated drinking water of affected water purveyors. Such actions may include, but not be limited to: 1) upgrading and maintaining adequate drinking water treatment systems, 2) developing or obtaining replacement surface water supplies from other water rights holders, 3) developing replacement groundwater supplies, or 4) physically routing a portion of the water diverted from the Sacramento River through the associated new conveyance pipelines/tunnel to affected purveyors.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A, although the isolated conveyance facilities of Alternative 6A would effectively isolate SWP and CVP export facilities in the southern Delta from the influence of potential new or modified sources of DOC relative to CM4–CM7 and CM10. However, the potential for CM4–CM7 and CM10 to contribute substantial amounts of DOC to raw drinking water supplies to the other Delta municipal intakes would remain, and could possibly be measurably worse in actual comparison to the dual conveyance project alternatives. With relatively less low DOC Sacramento River water in the Delta, there effectively would be less dilution of interior Delta DOC sources, leading to effectively higher long-term average DOC concentrations. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 6A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Effects of CM4–CM7 and CM10 on DOC under Alternative 6A would be similar, and possibly greater, to those discussed for Alternative 1A, except that SWP and CVP export facilities would be isolated from these effects by Alternative 6A design. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on pathogens under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on pathogens under Alternative 6A would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on pathogens under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 6A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 6A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 6% during the summer and 3% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 7% during the summer, but would increase by as much as 9% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 7% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 6A, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction was evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 6A modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, *Source Water Fingerprinting Results*). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase by 13% in July and 19% in August. At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–19% from October through June (11% for January through March of the modeled drought period). While these changes at Buckley Cove and Antioch are not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, modeled San Joaquin River source water fractions would increase between 14–34% for the entire calendar year of January through December (12–28% for October through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 26–76% (11–74% for the modeled drought period) for the entire calendar year. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 19%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 80% during October through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under Alternative 6A, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 20% in July (36% for the modeled drought period) and 27% in August (52% for the modeled drought period) (Appendix 8D, *Source Water Fingerprinting Results*). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. Although these modeled changes in the source water fractions at Buckley Cover are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, relative to the No Action Alternative, changes in source water fractions at Rock Slough, Contra Costa PP No. 1 and Franks Tract could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides at Delta interior locations relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 6A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 19–79% for the entire period of January through December (12–56% for January through December of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 33–96% for the entire period of January through December (17–89% for January through December of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 6A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 6A, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 6A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 6A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 6A. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2–CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*:** Effects of CM2–CM21 on pesticides under Alternative 6A are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 6A, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 6A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 6A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 6A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 6A, which are considered to be not adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 5, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-16 and M-26 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-23 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 6A would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at interior and western Delta locations would increase by 0.01–0.17 μg/L for the entire period modeled (1976–1991). These increases in selenium concentrations in water would result in reductions in available assimilative capacity of 1–16%, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 6A (range 0.09–0.40 μg/L) would be similar to Existing Conditions (range 0.09–0.41 μg/L) and the No Action Alternative (range 0.09–0.38 μg/L), and all would be below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would generally result in small increases (less than 4%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-26). Despite the small increases in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 41% relative to Existing Conditions and 42% relative to the No Action Alternative in all years (from about 4.7 to 6.6 mg/kg dry weight). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 24% in all years (from about 4.4 to 5.5 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by about 14% and 28% at those locations. Detection of small changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative) and for all years at both locations, whereas Existing Conditions and the No Action Alternative do not (quotients increase from 0.94 to 1.3 at San Joaquin at Antioch, and from 0.88 to 1.1 at Sacramento River at Mallard Island (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years in the San Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from 0.85–0.86 to 1.1) (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 6A would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 6A in the South Delta are expected to increase by more than 53 days (Table 8-60a). and in the East Delta increase by more than 32 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions, and 4 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small increases in selenium concentrations throughout the Delta for most biota (less than 4%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.3, and from 0.88 to 1.1 at Sacramento River at Mallard Island. The High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon at Antioch in drought years would increase from 0.85 for Existing Conditions and 0.86 for the No Action Alternative to 1.1, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increases for Alternative 6A are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 6A would result in moderate (0.12–0.19 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 11–20%, relative to the 1.3 μg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore the modeled selenium concentrations in water for Alternative 6A (0.09 μg/L) would be below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small changes (less than 5%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-26). Concentrations in biota would not exceed any selenium benchmarks for Alternative 6A (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 6A are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an average of 27%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks would be exceeded, these potentially measurable increases represent an adverse impact.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would result in small changes in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an average of 27%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential adverse impact on fish and wildlife beneficial uses.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 6A would cause no increase in the frequency with which applicable benchmarks would be exceeded and would improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria; however, significant impacts on some beneficial uses of waters in the Delta could occur because high toxicity benchmarks may be exceeded (where they are not under Existing Conditions), and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 6A would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, *Source Water Fingerprinting Results*). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 6A would not result in substantial increases in trace metal concentrations in SWP/CVP export service area waters under Alternative 6A, relative to Existing Conditions and the No Action Alternative. Unlike current conditions, however, water delivered to the SWP and CVP export service area would be entirely sourced to the Sacramento River, and thus the future trace metals profile would reflect that of the Sacramento River. While the change in trace metal concentrations in SWP and CVP export service area would likely be measurable, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP/CVP service area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 6A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 6A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 6A.

The assessment of the Alternative 6A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 6A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** CM2–CM21 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 6A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 6A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on TSS and turbidity under Alternative 6A would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion**:** Effects of CM1 on TSS and turbidity under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 6A, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on TSS and turbidity under Alternative 6A would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to conservation measures proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The conveyance features for CM1 under Alternative 6A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 6A and Alternative 1A is that under Alternative 6A, there would be additional features constructed to create the isolated conveyance system. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 6A, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

***NEPA Effects*:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM21 under Alternative 6A would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6A would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of Alternatives*, and Appendix 3B for additional information regarding the environmental commitments and environmental permits). Consequently, relative to Existing Conditions, Alternative 6A would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 6A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 6A, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 6A compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 6A, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta. Water exported from the Delta under Alternative 1A will be a mixture of *Microcystis*-affected water from the existing south Delta intake and unaffected Sacramento River water from the north Delta intake, which contrasts to Alternative 6, under which water exported to the SWP/CVP Export Service Areas consist entirely of water from the Sacramento River from the north Delta that is in unaffected by *Microcystis*. Because of this, the effects of *Microcystis* on and the microcystin concentrations of water exported to the SWP/CVP Export Service Areas could decrease under Alternative 6A, relative to Existing Conditions.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 6A, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 6A may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 6A would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 6A operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 6A operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 6A, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 6A will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 6A, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 6A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 6A, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 6A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 6A, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 6A. Water exported from the Delta to the Export Service Area will consist entirely of Sacramento River water from the north Delta which is unaffected by *Microcystis*. Operations and maintenance (CM1) under Alternative 6A, relative to existing conditions, is not expected to result in increased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 6A would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 6A would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans.Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 6A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 6A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because

Microcystis are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 6A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 6A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 5%, relative to Existing Conditions, and increase by 40%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 6A would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 6A is estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 6A. Mercury load to the Bay is estimated to increase by 12 kg/year (5%), relative to Existing Conditions, and 9 kg/year (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.37 kg/year (10%), relative to Existing Conditions, and increase by 0.28 kg/year (7%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 272 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 6A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 6A, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%, relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 6A, the long-term average total selenium concentration of the North Bay is estimated to be 0.16µg/L and the dissolved selenium concentration is estimated to be 0.14 µg/L, which would be a 0.03 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 6A, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1A–5, but still low (0.03 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (San Francisco Estuary Institute 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 6A are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 6A could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 6A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 6A could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 6A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 5% decrease in total nitrogen load and 40% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (9 kg/year; 3%) and methylmercury load (0.37 kg/year; 10%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

In regard to selenium, the estimated increase in selenium load would be 24% and the estimated increase in dissolved selenium concentrations would be 0.03 μg/L. Though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus, the increase in selenium load may make the CWA section 303(d) selenium impairment measurably worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.12 Alternative 6B—Isolated Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6B would comprise physical/structural components similar to those under Alternative 1B with the principal exception that Alternative 6B would be an “isolated” conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6B would utilize five screened intakes (i.e., Intakes 1 through 5) to convey up to 15,000 cfs of water from the north Delta to the south Delta through a canal along the east side of the Delta. An intermediate pumping plant north of the town of Holt would be constructed as well as a new 600-acre Byron Tract Forebay located adjacent to Clifton Court Forebay. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.12, for additional details on Alternative 6B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6B has the same diversion and conveyance operations as Alternative 6A. The primary difference between the two alternatives is that conveyance under Alternative 6B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 6B has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

NEPA Effects: The primary difference between Alternative 6B and Alternative 1A is that under Alternative 6B, a canal would be constructed for conservation measure CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.12). The remainder of the facilities constructed under Alternative 6B, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 6B would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. However, given the substantial differences in the conveyance features under CM1 with construction of a canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6B would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6B would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to Existing Conditions, Alternative 6B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 6B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.13 Alternative 6C—Isolated Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario D)

Alternative 6C would comprise physical/structural components similar to those under Alternative 1C with the principal exception that Alternative 6B would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6C would utilize five screened intakes (i.e., Intakes 1 through 5) to convey up to 15,000 cfs of water from the north Delta to the south Delta through a series of canals and tunnels along the west side of the Delta. An intermediate pumping plant would be utilized and a new 600-acre forebay at Byron Tract would be constructed adjacent Clifton Court Forebay. There would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes Fall X2. CM2–CM21 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.13, for additional details on Alternative 6C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6C has the same diversion and conveyance operations as Alternative 6A. The primary differences between the two alternatives are that conveyance under Alternative 6C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Water Quality Effects Resulting from Implementation of CM2–CM21

Alternative 6C has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

NEPA Effects: The primary difference between Alternative 6C and Alternative 1A is that under Alternative 6C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.13). The remainder of the facilities constructed under Alternative 6C, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 6C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of a canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to Existing Conditions, Alternative 6C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 6C for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.3.3.14 Alternative 7—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Enhanced Aquatic Conservation (9,000 cfs; Operational Scenario E)

Alternative 7 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 7 would construct only three intakes and intake pumping plants (i.e., Intakes 2, 3, and 5). Alternative 7 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A 750-acre intermediate forebay and pumping plant would be constructed near Hood. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario E, which includes Fall X2. The modifications under this enhanced aquatic alternative are intended to further improve fish and wildlife habitat, especially along the San Joaquin River. CM2–CM21 (CM2–CM21) would be implemented under this alternative, and would be the same as those under Alternative 1A, except that 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. See Chapter 3, *Description of Alternatives*, Section 3.5.14, for additional details on Alternative 7.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 7, over the long term, average annual delta exports are anticipated to decrease by 1,389 TAF relative to Existing Conditions, and by 682 TAF relative to the No Action Alternative. Since, over the long-term, approximately 62% of the exported water will be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is greatly increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 7–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 7, long-term average annual Delta outflow is anticipated to increase 1,383 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this would be decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 7 would be greater relative to the Existing Conditions because Existing Conditions do not include operations to meet Fall X2, whereas the No Action Alternative and Alternative 7 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 7 by 683 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 7–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 7 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-70 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 7 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, July through September, November, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 7, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 7 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 7, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-70. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 7

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 7	0.073	0.086	0.070	0.061	0.058	0.061	0.058	0.064	0.065	0.061	0.069	0.066	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 7 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 7, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

***NEPA Effects*:** In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 7, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 7, relative to Existing Conditions.

There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on ammonia under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 7 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin

River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 7 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, *Boron*, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 7 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Effects of CM1 on boron under Alternative 7 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 10% at the SF Mokelumne River at Staten Island, 33% at Franks Tract, and 56% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-18). The comparison to Existing Conditions reflects changes due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and the No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 33% at Franks Tract and up to 56% at Old River at Rock Slough locations (Appendix 8F, Table Bo-19). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 7, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 7 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 7, long-term average boron concentrations would decrease by as much as 41% at the Banks Pumping Plant and by as much as 48% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-18) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 7 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 7 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 56% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 7 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 7 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 7, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 7 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on boron under Alternative 7 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 7 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 7 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 7 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 7, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Similar to the No Action Alternative, these decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 7, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 7 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough (for the modeled drought period only), while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 16). At Barker Slough, predicted long-term average bromide concentrations would decrease from 51 μg/L to 50 μg/L (2% relative decrease) for the modeled 16-year hydrologic period, but would increase from 54 μg/L to 72 μg/L (34% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 29% under Alternative 7, but would increase slightly from 55% to 57% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 8% under Alternative 7, and would increase from 0% to 22% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 μg/L to 63 μg/L (27% relative increase) for the modeled 16-year hydrologic period and would increase from 51 μg/L to 64 μg/L (25% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 μg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 7 (52% to 88% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 μg/L threshold would increase slightly, from 82% under Existing Conditions to 99% under Alternative 7 (78% to 97% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative would be generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 16). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 1% (34% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 31% (29% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤9%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 7 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 16). Such similarity demonstrates that the modeled Alternative 7 change in bromide is almost entirely due to Alternative 7 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 7 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 17). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 2% exceedance over the modeled period under Alternative 7, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 7% under Alternative 7.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 μg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 7 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 152 μg/L (48% increase) at City of Antioch and would increase from 150 μg/L to 204 μg/L (36% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25).

Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 7 would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 16–32%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 7, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 71% relative to Existing Conditions and 67% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 16). As a result, exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be substantially reduced, resulting in considerable overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 17).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 7 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 7 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects. Iimplementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 7 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 7 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 7, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 7 would result in substantial increases in long-term average bromide concentration at Staten Island and Barker Slough (for the modeled drought period only). There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. While the increase in long-term average bromide concentrations at Barker Slough are predicted to be relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period would represent a substantial change in source water quality during a season of drought. These predicted drought season related increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 7, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 71% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 7 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 7, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 7 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough (drought period only) and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34% during the modeled drought period. For the modeled 1 drought period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 7. Substantial changes in long-term average bromide during seasons of drought could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough during the drought period is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 7 would be similar to conservation measures under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. As discussed for Alternative 1A, implementation of the CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 7, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM21 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 7 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-62). Consequently, Alternative 7 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3) increased concentrations at the Contra Costa Canal at Pumping Plant #1 (i.e., up to 29% compared to No Action Alternative), Rock Slough (i.e., up to 22% compared to No Action Alternative), and the SF Mokelumne at Staten Island (i.e., up to 28% compared to Existing Conditions and No Action Alternative) (Appendix 8G, *Chloride*, Table Cl-43 and Table Cl-44). Moreover, the direction and magnitude of predicted changes for Alternative 7 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 7, the modeled frequency of objective exceedance would increase from 7% of years under Existing Conditions and 0% under the No Action Alternative to 20% of years under Alternative 7 (Appendix 8G, *Chloride*, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 7, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 7 (Appendix 8G, *Chloride*, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 12% (i.e., 24% for Existing Conditions to 12%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride*, Table Cl-45 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 60%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-45) and no substantial long-term degradation (Appendix 8G, Table Cl-47). However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in August through October (i.e., reduction ranging from 35% to 74% for the 16 year period modeled, and 100% in August and September [i.e., eliminated]) (Appendix 8G, Table Cl-47), thus reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, *Chloride*, Table Cl-46 and Table Cl-48). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would generally be similar compared to Existing Conditions and No Action Alternative, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16). Although modeling of Alternative 7 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original

Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 7, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 70% relative to Existing Conditions and 66% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-43). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-45). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, *Chloride*, Table Cl-44 and Table Cl-46).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 7 would result in substantial increased water quality degradation relative to the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, and potentially measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7;

implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 7 would contribute substantially to the adverse water quality effects.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 7 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 7 operations would result in reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 7 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on aquatic life beneficial uses in the interior Delta and fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Under Alternative 7, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2–CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 7 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on DO under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 7, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on DO under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 7 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 7 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 7 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at San Andreas Landing, Prisoners Point, and Brandt Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-7).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 19% under Alternative 7, and the percent of days out of compliance would increase from 11% under Existing Conditions to 29% under Alternative 7.

The percentage of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 4% under Alternative 7, and the percentage of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 7% under Alternative 7. Sensitivity analyses were performed for Alternative 4 Scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percentage of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 40% under Alternative 7, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 40% under Alternative 7. Sensitivity analyses conducted for Alternative 4 Scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, *Electrical Conductivity*, Attachment 1, for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

In the San Joaquin River at Brandt Bridge, the percentage of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 7; the percentage of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 7. These changes are minimal, and are not considered substantial in light of overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–46% for the entire period modeled and 2–45% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-18). In the S. Fork Mokelumne River at Terminous, average EC would increase 6% for the entire period modeled and 5% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-18). Average EC in the San Joaquin River at Prisoners Point would increase by 1% during the drought period (Appendix 8H, Table EC-18). Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise.

Relative to the No Action Alternative, the percentage of days exceeding EC objectives and percentage of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Vernalis, Brandt Bridge, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-7). The increase in percentage of days exceeding the EC objective would be 39% at Prisoners Point and 5% or less at the remaining locations. The increase in percentage of days out of compliance would be 30% at Prisoners Point and 6% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River (6%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (10%) (Appendix 8H, Table EC-18). During the drought period modeled, average EC would increase at: S. Fork Mokelumne River (6%), San Joaquin River at Brandt Bridge (1%) and Prisoners Point (8%), and Old River at Tracy Bridge (1%) (Appendix 8H, Table EC-18). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 7, relative to Existing Conditions, during the months of April and May by 0.2 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–3.3 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases of 0.1–1.6 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 7 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 7 would result in no exceedances of the Bay-Delta WQCP’s 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 7.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 7 would decrease substantially: 47% for the entire period modeled and 51% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 43% for the entire period modeled and 46% during the drought period modeled (Appendix 8H, Table EC-18).

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 7 would also decrease substantially: 52% for the entire period modeled and 59% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 50% for the entire period modeled and 57% during the drought period modeled. (Appendix 8H, Table EC-18)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 7 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 7 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 7 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives in the western Delta under Alternative 7, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives in this portion of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects. Implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 7 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 7 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 13% increase), and San Joaquin River at Prisoners Point (fish and wildlife objective; 34% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this portion of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 7 could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that could occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses.

However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on EC under Alternative 7 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 7, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 7 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 7.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 7 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed a 7% reduction at Old River at Rock Slough and Contra Costa Pumping Plant, and a 6.6% reduction at those same locations relative to the No Action Alternative. These changes are not expected to result in adverse effects to beneficial use (Figures 8-53a and 8-54a). Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.164 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, *Mercury*, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest changes in exceedance quotients relative to Existing Conditions and the No Action Alternative are 30–39% at the Contra Costa Pumping Plant and 32–45% for Old River at Rock Slough (Figures 8-55a and 8-55b; Appendix 8I, Table I-14b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 7 are projected to be lower than Existing Conditions and the No Action Alternative (Appendix 8I, *Mercury*, Figures I-8 and I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 7, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 30% improvement relative to Existing Conditions, 32% relative to the No Action Alternative)(Figures 8-55a and 8-55b; Appendix 8I, Table I-14b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 7 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 7, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for Alternative 7 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 7 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to

Existing Conditions, Alternative 7 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Some habitat restoration activities under Alternative 7 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 7 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 7 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 7.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 7 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 7, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 7.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 25 and 26). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase). Long-term average concentrations were estimated to increase to 0.67, 1.04 and 1.10 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant#1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Appendix 8D, *Source Water Fingerprinting Results*). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 6% on a long-term average basis (Appendix 8J, Table 27). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 6%, and averaged 3% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Appendix 8J, Table 27).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility’s discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 7, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but

would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 7, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 7, the increase is expected to be greater under Existing Conditions than for Alternative 7 due to the upgrades that are assumed under Alternative 7.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Tables 25 and 26). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Appendix 8J, Table 27).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated. Monthly average use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants in drought conditions was at times >50%, but the absolute value of these changes (i.e., in mg/L-N) was small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on nitrate under Alternative 7 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 7, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 7, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 7, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.7–1.1 mg/L would be predicted (≤30% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, *Organic Carbon,* DOC Table 8). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 85% under the Alternative 7 (an increase from 47% to 82% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 47% (32% to 57% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 85% under Alternative 7 (45% to 88% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 52% (35% to 58% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise.

In comparison, Alternative 7 relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.7–1.0 mg/L DOC (i.e., ≤26%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative) (Appendix 8K, *Organic Carbon,* DOC Table 8). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 57% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 7 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 7, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 7 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease <0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 7, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.1 mg/L (1.3 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 8). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.0 mg/L (1.2 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. Average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 67% at Banks and 61% at Jones under Alternative 7 (60% and 57%, respectively during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤15% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 7, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.4 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.0 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 7 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 7 would result in substantial increases (i.e., 0.7–1.1 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve

EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 7 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 1.3 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤15% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 7 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 7, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 7 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.7–1.1 mg/L, equivalent to ≤30% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 7, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the discussion of Alternative 6A.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 under Alternative 7 would be similar to conservation measures under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A, except that the increased linear miles of channel margin habitat enhancement and increased acreage of seasonally inundated floodplain would increase the overall Alternative 7 DOC loading to the Delta. In total, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 7 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Effects of CM4–CM7 and CM10 on DOC under Alternative 7 are similar to, and possibly greater than, those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on pathogens under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on pathogens under Alternative 7 would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on pathogens under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 7 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 7, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 5% during the summer, but would increase as much as 7% in the winter. American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 7, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 7 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, *Source Water Fingerprinting Results*). At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–14% from November through May (no increase >10% for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 18–28% for October through June (12–25% for November through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 27–71% (11–70% for the modeled drought period) for October through June. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 16% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 6%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento

River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 81% during November through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 14% in August when compared to No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River at Buckley Cove during the modeled drought period would only account for 36% of the total source water volume in July and 26% in August. These changes at Buckley Cove are not considered substantial, however, as discussed for Existing Conditions, under the No Action Alternative the similar magnitude change at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially alter the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 7, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 27–79% for October through June (13–32% for December through March of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 43–96% for October through June (37–89% for October through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 7 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 7, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 7 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 7 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 7. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 7 would be similar to conservation measures under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2–CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion: Effects of CM2–CM21 on pesticides under Alternative 7 are similar to conservation measures discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 7, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 7, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 7, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 7 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 7, which are considered to be not adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 7, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-17 and M-27 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 7 would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.13 µg/L for the entire period modeled. The increases in selenium concentrations in water would result in reductions in available assimilative capacity for selenium of 1–12%, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water under Alternative 7 (range 0.09–0.38 µg/L) would be similar to those for Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and all would be well below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would generally result in small changes (less than 4%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-27). Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 30% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.1 mg/kg dry weight). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 18% in all years (from about 4.4 to 5.2 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by 11–24% at those locations. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative) and for all years at the San Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from 0.94 to 1.2 at San Joaquin at Antioch) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years in the San Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from about 0.85 to 1.1) (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 7 would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 7 in the South Delta are expected to increase by more than 35 days (Table 8-60a). and in the East Delta increase by more than 20 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions, and 1 day relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small changes (less than 4%) in selenium concentrations throughout the Delta for most biota, although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.2, and from 0.88 to 1.0 at Sacramento River at Mallard Island. The High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon at Antioch would increase from 0.85 for Existing Conditions and 0.86 for the No Action Alternative to 1.1. Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall the predicted increase for Alternative 7 is high enough that it may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 7 would result in moderate (0.09–0.15 µg/L) decreases in average selenium concentrations in water at the Banks and Jones pumping plants, relative to the Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result increases in available assimilative capacity for selenium at these pumping plants of 9–16%, relative to the USEPA draft water quality criterion of 1.3 µg/L. Furthermore, the long-term average selenium concentrations in water for Alternative 7 (range 0.12–0.13 µg/L) would be well below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small changes (less than 3%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at Banks and Jones pumping plants (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-27). Concentrations in biota would not exceed any selenium benchmarks for Alternative 7 (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 7 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an average of 21%, which may represent a measurable increase in the environment. These potentially measurable increases represent an adverse impact.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 21%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are exceeded, these potentially measurable increases represent a potential impact to fish and wildlife beneficial uses.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 7 would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria; however, significant impacts on some beneficial uses of waters in the Delta could occur because high toxicity benchmarks would be exceeded (where they are not under Existing Conditions), and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. *AMM27 Selenium*

Management, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 7 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, *Source Water Fingerprinting Results*). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 7 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 7, relative to Existing Conditions and the No Action Alternative. As such, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***NEPA Effects*:** In summary, Alternative 7, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 7 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 7.

The assessment of the Alternative 7 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 7 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 7, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 7 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on TSS and turbidity under Alternative 7 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion: Effects of CM1 on TSS and turbidity under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 7, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on TSS and turbidity under Alternative 7 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to conservation measures proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The conveyance features for CM1 under Alternative 7 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 7 and Alternative 1A is that under Alternative 7, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. Additional construction activity also would occur to restore channel margin and seasonally inundated floodplain habitats. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 7, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 7, there would be up to 20,000 acres of inundated floodplain habitat restored (as opposed to 10,000 acres under the majority of the other alternatives), thus resulting in increased construction-related disturbances.

NEPA Effects**:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM21 under Alternative 7 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 7 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 7 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Because environmental commitments would be implemented under Alternative 7 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 7, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 7 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 7, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various

Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 7, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 7 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 7 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 7 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 7 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 7, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 7 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 7, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 7 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 7, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 7. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 7, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 7. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 7, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in Microcystis occurrences due to climate change and sea level rise may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 7 would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measure WQ-32a. The effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 7 would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in Microcystis occurrences due to climate change and sea level rise may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 7 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 7 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 7 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 7 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 13%, relative to Existing Conditions, and increase by 28%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 7 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 7 is estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 7. Mercury load to the Bay is estimated to increase by 10 kg/year (4%), relative to Existing Conditions, and 7 kg/year (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.29 kg/year (8%), relative to Existing Conditions, and increase by 0.20 kg/year (5%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 270 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 7 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 7, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 20%, relative to Existing Conditions, and increase by 16%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 7, the long-term average total selenium concentration of the North Bay is estimated to be 0.15 µg/L and the dissolved selenium concentration is estimated to be 0.13 µg/L, which would be a 0.02 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations in water projected to occur under Alternative 7, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1A–5, but still low (0.02 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (San Francisco Estuary Institute 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 7 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 7 could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 7, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS.

However, Alternative 7 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 7 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 13% decrease in total nitrogen load and 9% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (10 kg/year; 4%) and methylmercury load (0.29 kg/year; 8%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

In regard to selenium, the estimated increase in selenium load would be 20% and the estimated increase in dissolved selenium concentrations would be 0.02 μg/L. Though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus, the increase in selenium load may make the CWA section 303(d) selenium impairment measurably worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.15 Alternative 8—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Increased Delta Outflow (9,000 cfs; Operational Scenario F)

Alternative 8 would comprise physical/structural components similar to those under Alternative 1A with the principal exceptions that Alternative 8 would have only three intakes and intake pumping plants (i.e., Intakes 2, 3, and 5). Alternative 8 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A 750-acre intermediate forebay and pumping plant would be constructed near Hood. A new 600-acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario F, which includes Fall X2. The alternative would provide up to 1.5 MAF in increased Delta outflow. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.15, for additional details on Alternative 8.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 8, over the long term, average annual delta exports are anticipated to decrease by 2,046 TAF relative to Existing Conditions, and by 1,342 TAF relative to the No Action Alternative. Because, over the long-term, approximately 70% of the exported water would be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply,* for more information). The result of this would be greatly increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 8–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 8, long-term average annual Delta outflow is anticipated to increase 2,195 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario F) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 8 is greater relative to the Existing Conditions because it does not include operations to meet Fall X2, whereas the No Action alternative and Alternative 8 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 8 by 1,445 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 8–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 8 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-71 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 8 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 8, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 8 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 8, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-71. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 8

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 8	0.081	0.089	0.070	0.060	0.057	0.059	0.055	0.059	0.066	0.072	0.078	0.070	0.068

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 8 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 8, relative to the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 8, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 8, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on ammonia under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 8 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin

River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and the No Action Alternative considering only changes due to Alternative 8 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, *Boron*, Bo-24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 8 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Effects of CM1 on boron under Alternative 8 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in increased long-term average boron concentrations for the 16-year period modeled at interior Delta locations (by as much as 10% at the SF Mokelumne River at Staten Island, 35% at Franks Tract, 58% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-20). The comparison to Existing Conditions reflects changes due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations.

The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 16% at Franks Tract and up to 34% at Old River at Rock Slough locations (Appendix 8F, Table Bo-21). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 8, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 8 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 8, long-term average boron concentrations would decrease by as much as 37% at the Banks Pumping Plant and by as much as 47% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-20) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 8 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 8 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 58% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 8 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 8 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 8 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 8, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 8 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on boron under Alternative 8 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 8 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 8 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 8 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 8, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to No Action Alternative (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 8, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 8 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 18). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 54 µg/L (4% relative increase) for the modeled 16-year hydrologic period, and would increase from 54 µg/L to 80 µg/L (50% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 34% under Alternative 8, but would increase slightly from 55% to 62% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 10% under Alternative 8, and would increase from 0% to 27% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 64 µg/L (29% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 65 µg/L (26% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 8 (52% to 87% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 µg/L threshold. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold would increase slightly, from 82% under Existing Conditions to 98% under Alternative 8 (78% to 93% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario F) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and the No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative tithe No Action Alternative are generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 18). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 8% (50% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 33% (30% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤2%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 8 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, Table 18). Such similarity demonstrates that the modeled Alternative 8 change in bromide is almost entirely due to Alternative 8 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 8 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 19). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 4% exceedance over the modeled period under Alternative 8, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 12% under Alternative 8.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 μg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 8 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 146 μg/L (42% increase) at City of Antioch and would increase from 150 μg/L to 193 μg/L (29% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25).

Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 8 would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 11–37%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 8, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 75% relative to Existing Conditions and 69% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 18). As a result, exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be substantially reduced, resulting in considerable overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 19).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 8 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 8 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects. Implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 8 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 8 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 8, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 8 would result in increases in long-term average bromide concentration at Staten Island and Barker Slough. There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. While the increase in long-term average bromide concentrations at Barker Slough are predicted to be relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period would represent a substantial change in source water quality during a season of drought. These predicted drought season related increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 8, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 75% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 8 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 8, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 8 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough (drought period only) and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 50% during the modeled drought period. For the modeled drought period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 27% under Alternative 8. Substantial changes in long-term average bromide during seasons of drought could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough during the drought period is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 8 would be similar to conservation measures under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 8, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM21 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 8 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-62). Consequently, Alternative 8 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 6% compared to No Action Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 24% compared to No Action Alternative), Rock Slough (i.e., up to 18% compared to No Action Alternative), and the SF Mokelumne at Staten Island (i.e., up to 29% compared to No Action Alternative) (Appendix 8G, *Chloride*, Table Cl-49 and Table Cl-50). Moreover, the direction and magnitude of predicted changes for Alternative 8 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 8, the modeled frequency of objective exceedance would increase from 7% of years under Existing Conditions and 0% under the No Action Alternative to 13% of years under Alternative 8 (Appendix 8G, *Chloride*, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 8, the modeled frequency of objective exceedance would decrease, from

6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 8 (Appendix 8G, *Chloride*, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 15% (i.e., 24% for Existing Conditions to 9%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride*, Table Cl-51 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 58%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-51) and no substantial long-term degradation (Appendix 8G, Table Cl-53). However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in September and October (i.e., up to 100%, or eliminated, for the drought period modeled) (Appendix 8G, Table Cl-53), reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-52 and Table Cl-54). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed W*ater Bodies*

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would generally be similar compared to Existing Conditions and No Action Alternative, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally be similar, or decrease, compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13). However, chloride concentrations would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16). Although modeling of Alternative 8 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 8, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 73% relative to Existing Conditions and 70% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-49). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-51). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-50 and Table Cl-52).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 8 would result in substantial increased water quality degradation relative to the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, and could contribute to measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 8 would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 8 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 8 operations would result in reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at interior and western Delta locations would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 8 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 8 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Under Alternative 8, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM21 for Alternative 8 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on DO under Alternative 8 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Effects of CM1 on DO under Alternative 8 would be similar to conservation measures discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 8, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on DO under Alternative 8 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 8 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 8 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 8 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at Vernalis, Prisoners Point, and Brandt Bridge, and in the Old River near Middle River (Appendix 8H, *Electrical Conductivity*, Table EC-8).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 22% under Alternative 8, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 34% under Alternative 7.

The increase in the percentage of days the Vernalis EC objective would be exceeded would be <1%, and the percentage of days out of compliance with the EC objective would increase from 7% under Existing Conditions to 8% under Alternative 8. These increases are minimal, and are not considered substantial, in light of the overall modeling uncertainty.

The percentage of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 38% under Alternative 8, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing

Conditions to 38% under Alternative 8. Sensitivity analyses conducted for Alternative 4 Scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, *Electrical Conductivity*, Attachment 1, for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

In the San Joaquin River at Brandt Bridge, the percentage of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 8; the percentage of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 8. The increase in the percentage of days the Old River EC objective would be exceeded and out of compliance for the entire period modeled (1976–1991) would be <1%. These increases are minimal, and are not considered substantial, in light of the overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–44% for the entire period modeled and 2–43% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-19). In the S. Fork Mokelumne River at Terminous, average EC would increase 5% for the entire period modeled and drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-19). Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 8, relative to Existing Conditions has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario F) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percentage compliance with Bay-Delta WQCP EC objectives under Alternative 8 would be similar to that described above relative to Existing Conditions. The exception is that there would also be a slight increase (<1%) in the percentage of days the EC objective would be exceeded in the Old River at Tracy for the entire period modeled. Also, Old River at Tracy also would have an increase in the number of days out of compliance with the EC objectives. The percentage of days out of compliance with Tracy Bridge EC objectives would increase from 8% to 9% for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in the San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase would occur in the San Joaquin River at Prisoners Point (7%); the increase at the other locations would be <1–6% (Appendix 8H, Table EC-19). Similarly, during the drought period modeled, average EC would increase at all locations, except the San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (6%); the increases at the other locations would be 1–4% (Appendix 8H, Table EC-19). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of

EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario F).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would decrease under Alternative 8, relative to Existing Conditions, during October–May in the Sacramento River at Collinsville and Montezuma Slough at National Steel (Appendix 8H, *Electrical Conductivity*, Tables EC-21 and EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.1–3.5 mS/cm, depending on the month (Appendix 8H, Table EC-23). Sunrise Duck Club would have long-term average EC increases of 0.2–0.8 mS/cm (Appendix 8H, Table EC-24) and Volanti Slough would have long-term average EC increases of 0.1–1.1 mS/cm. The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The long-term average EC increase in Suisun Marsh may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 8 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 8 would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical*

Conductivity, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 8.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 8 would decrease substantially: 49% for the entire period modeled and 53% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 45% for the entire period modeled and 50% during the drought period modeled (Appendix 8H, Table EC-19).

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 8 would also decrease substantially: 53% for the entire period modeled and 62% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 51% for the entire period modeled and 60% during the drought period modeled. (Appendix 8H, Table EC-19)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 8 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 8 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 8 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

***NEPA Effects*:** In summary, the increased frequency of exceedance of EC objectives in the western Delta under Alternative 8, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives in this portion of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects. Implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 8 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 8 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 16% increase) and Prisoners Point (fish and wildlife objective; 32% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in this portion of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 8 could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments, AMMs, and CMs*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on EC under Alternative 8 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 8, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the

Sacramento River under Alternative 8 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 8.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 8 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 7% for the Contra Costa Pumping Plant, and 6.9% at the same location for the No Action Alternative (Figures 8-53a and 8-54a). Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions and slightly lower than the No Action Alternative (Appendix 8I, Figure I-9). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show more substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest changes in exceedance quotients relative to Existing Conditions and the No Action Alternative are 33–40% at the Contra Costa Pumping Plant and 34–46% for Old River at Rock Slough (Figures 8-55a and 8-55b; Appendix 8I, *Mercury*, Table I-15b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 8 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-8 and I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 8, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 27% improvement relative to Existing Conditions, 31% relative to the No Action Alternative) (Figures 8-55a and 8-55b; Appendix 8I, Table I-15b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 8 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 8, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for Alternative 8, relative to Existing Conditions.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 8 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 8 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.

This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Some habitat restoration activities under Alternative 8 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 8 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 8 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 8.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and

- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 8 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 8, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to No Action (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 8.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 28 and 29). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase). Long-term average concentrations were estimated to increase to 0.68, 1.06 and 1.13 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant#1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Appendix 8D, *Source Water Fingerprinting Results*). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, Table 28). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 6% on a long-term average basis (Appendix 8J, Table 30). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 6%, and averaged 3% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Appendix 8J, Table 30).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 8, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 8, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 8, the increase is expected to be greater under Existing Conditions than for Alternative 8 due to the upgrades that are assumed under Alternative 8.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Tables 28 and 29). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.5 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Appendix 8J, *Nitrate*, Table 28). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Appendix 8J, Table 30).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects**:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated. Monthly average use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants in drought conditions was at times >50%, but the absolute value of these changes (i.e., in mg/L-N) was small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on nitrate under Alternative 8 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 8, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 8, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 8 relative to Existing Conditions, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for

Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.7–1.1 mg/L would be predicted (≤32% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, *Organic Carbon,* DOC Table 9). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 90% under the Alternative 8 (an increase from 47% to 88% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 48% (32% to 57% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 93% under Alternative 8 (45% to 95% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 55% (35% to 60% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other components of Operational Scenario F) and climate change/sea level rise.

In comparison, Alternative 8 relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.7–1.0 mg/L DOC (i.e., ≤27%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 9). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 32% (42% to 58% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 8 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 8, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 8 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease ≤0.1 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 8, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.0 mg/L (1.2 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 9). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.0 mg/L (1.1 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. Average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 63% at Banks and 61% at Jones under Alternative 8 (62% and 57%, respectively during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤17% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 8, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.3 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.0 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 8 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 8 would result in substantial increases (i.e., 0.7–1.1 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 8 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 1.2 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤17% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 8 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 8, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 8 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.7–1.1 mg/L, equivalent to ≤32% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No.1. In particular, under Alternative 8, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the discussion of Alternative 6A.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 8 would be similar to conservation measures under Alternative 1A. Effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In total, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 8 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion**:** Effects of CM4–CM7 and CM10 on DOC under Alternative 8 are similar to, and possibly greater than, those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments, AMMs, and CMs*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on pathogens under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Effects of CM1 on pathogens under Alternative 8 would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on pathogens under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 8 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 8, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 8% during the summer and 1% during the winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would decrease no more than 18% during the summer, but would increase as much as 30% in the winter. American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 5% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤18% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 8, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction was evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 8 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, *Source Water Fingerprinting Results*). At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–14% from November through May (no increase >10% for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 18–29% for October through June (11–25% for November through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 28–72% (15–71% for the modeled drought period) for October through June. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 15% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 8%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be ≥50%, and as much as 81% during November through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 23% in July and 28% in August when compared to No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River at Buckley Cove during the modeled drought period would only account for 44% of the total source water volume in July and 39% in August. These changes at Buckley Cove are not considered substantial, however, as discussed for Existing Conditions, under the No Action Alternative the similar magnitude change at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially alter the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 8, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 26–78% for October through June (6–45% for December through March of the modeled drought period) and at

Jones pumping plant Sacramento source water fractions would generally increase from 42–95% for October through June (37–88% for October through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 8 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 8, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 8 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 8 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 8. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** CM2–CM21 under Alternative 8 would be similar to conservation measures under Alternative 1A. Effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*:** Effects of CM2–CM21 on pesticides under Alternative 8 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 8, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 8, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 8, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 8 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 8, which are considered to be not adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 8, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-18 and M-28 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 8 would result in small to moderate changes in average selenium concentrations in water at modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.14 µg/L for the entire period modeled (1976–1991). These increases in selenium concentrations in water would result in reductions in available assimilative capacity for selenium of 1-13%, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 8 (range 0.09–0.39 µg/L) would be similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and all would be below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would generally result in small changes (less than 4%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-28). Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 31% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.1 mg/kg dry weight). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 17% in all years (from about 4.4 to 5.2 mg/kg dry weight) (Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by 23% at Antioch and 11% at Mallard Island. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative) and for all years at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from 0.94 to 1.2 at Antioch) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at Antioch unlike Existing Conditions and the No Action Alternative (quotient increases from 0.85 to 1.1) (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 8 would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 8 in the South Delta are expected to increase by more than 37 days (Table 8-60a). and in the East Delta increase by more than 23 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small changes in selenium concentrations throughout the Delta for most biota (less than 4%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed the lower benchmark for both western

Delta locations for all years and drought years, indicating a low potential for effects. Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increases for Alternative 8 are high enough that they may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 8 would result in moderate (0.08–0.15 μg/L) decreases in average selenium concentrations at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 8–16%, relative to the 1.3 μg/L ecological benchmark (Figures 8-59a and 8-60a). Furthermore, the long-term average selenium concentrations in water for Alternative 8 (range 0.09–0.39 μg/L) would be well below the USEPA draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small changes (less than 4%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at SWP/CVP service areas (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-28). Concentrations in biota would not exceed any selenium benchmarks for Alternative 8 (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 8 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an average of 30%, which may represent a measurable increase in the environment. These potentially measurable increases represent an adverse impact.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 8 would result in small changes in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 8 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 21%, which may represent a measureable increase in the environment. Because both low and high toxicity benchmarks are exceeded, these potentially measureable increases represent a potential impact on fish and wildlife beneficial uses.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 8 would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria; however, significant impacts on some beneficial uses of waters in the Delta could occur because uptake of selenium from water to biota may measurably increase such that high toxicity benchmarks may be exceeded. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 8 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 8 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, *Source Water Fingerprinting Results*). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 8 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 8 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 8, relative to Existing Conditions and the No Action Alternative. As such, Alternative 8 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 8, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 8 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 8 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 8.

The assessment of the Alternative 8 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 8 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 8 would be similar to conservation measures under Alternative 1A. Effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21 under Alternative 8, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 8 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 8 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 8, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on TSS and turbidity under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 8 would be similar to conservation measures proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The conveyance features for CM1 under Alternative 8 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 8 and Alternative 1A is that under Alternative 8, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. Additional construction activity also would occur to restore channel margin and seasonally inundated floodplain habitats. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 8, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 8, there would be up to 20,000 acres of inundated floodplain habitat restored (as opposed to 10,000 acres under the majority of the other alternatives), thus resulting in increased construction-related disturbances.

***NEPA Effects*:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM21 under Alternative 8 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 8 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 8 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Because environmental commitments would be implemented under Alternative 8 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 8, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 8 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 8, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 8, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 8 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 8 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 8 operations and maintenance, relative to the

No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 8 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 8, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 8 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 8, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 8 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 8, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 8. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 8, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 8. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 8, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 8 would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and

CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 8 would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 8 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 8 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 8 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 8 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 9%, relative to Existing Conditions, and increase by 33%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 8 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 8 is estimated to increase by 14%, relative to Existing Conditions, and increase by 9% relative to the No

Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 8. Mercury load to the Bay is estimated to increase by 16 kg/year (6%), relative to Existing Conditions, and 13 kg/year (5%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.40 kg/year (11%), relative to Existing Conditions, and increase by 0.31 kg/year (8%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 276 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 8 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 8, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%, relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 8, the long-term average total selenium concentration of the North Bay is estimated to be 0.16μg/L and the dissolved selenium concentration is estimated to be 0.14 μg/L, which would be a 0.03 μg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 μg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 8, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1A–5, but still low (0.03 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (San Francisco Estuary Institute 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 8 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 8 could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 8, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 8 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 8 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 9% decrease in total nitrogen load and 14% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (16 kg/year; 6%) and methylmercury load (0.40 kg/year; 11), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

In regard to selenium, the estimated increase in selenium load would be 24% and the estimated increase in dissolved selenium concentrations would be 0.03 μg/L. Though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus, the increase in selenium load may make the CWA section 303(d) selenium impairment measurably worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.16 Alternative 9—Through Delta/Separate Corridors (15,000 cfs; Operational Scenario G)

Under Alternative 9, two fish-screened intakes would be constructed–one at the Delta Cross Channel and the other at Georgiana Slough. Water would be conveyed through a flow-collection channel and radial gates, eventually reaching the existing channel. Once in the channel, water would flow south through the Mokelumne River and San Joaquin River to Middle River and Victoria Canal, which would be dredged to accommodate increased flows. Along the way, diverted water would be guided by operable barriers. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons, eventually reaching Clifton Court Forebay. From there, water would flow through existing SWP facilities, and a new canal would be constructed to connect the forebay to CVP facilities. Water supply and conveyance operational criteria under Alternative 9 would be guided by criteria identified in Scenario G. CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.16, for additional details on Alternative 9.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1A–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 9, over the long term, average annual delta exports are anticipated to decrease by 766 TAF relative to Existing Conditions, and by 63 TAF relative to the No Action Alternative. Although all of the diversions are from the existing south Delta intakes, the operable barriers included under this alternative would result in the exported water containing a higher proportion of Sacramento River water as opposed to San Joaquin River water (see Chapter 5, *Water Supply*, for more information). The result of this would be greatly increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, *Source Water Fingerprinting Results*, Figure 271, which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 9, long-term average annual Delta outflow is anticipated to increase 807 TAF relative to Existing Conditions, due to both changes in operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 9 would be greater relative to the Existing Conditions because Existing Conditions do not include operations to meet Fall X2, whereas the No Action Alternative and Alternative 9 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 9 by 57 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, Figure 271.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to

Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 9 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-72 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 9 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, July, October, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 9, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 9 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 9, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-72. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 9

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Alternative 9	0.076	0.084	0.070	0.061	0.058	0.061	0.058	0.063	0.067	0.061	0.067	0.064	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 9 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 9, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 9, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 9, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on ammonia under Alternative 9 would be the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 9 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and eastside tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with changed operations, climate change, and increased water demands) and the No Action Alternative considering only changes due to Alternative 9 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, *Boron*, Table Bo-32). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 9 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 9 would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, with a substantial reduction in boron concentrations in the San Joaquin River at Buckley Cove. Long-term average boron concentrations would increase at interior and western Delta locations (by as much as 66% at Franks Tract, 80% at Old River at Rock Slough, and 9% at the Sacramento River at Emmaton) (Appendix 8F, *Boron*, Table Bo-22). The comparison to Existing Conditions reflects changes due to both Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 33% at Franks Tract and up to 46% at Old River at Rock Slough locations (Appendix 8F, Table Bo-23). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 9, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 9 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 9, long-term average boron concentrations would decrease by as much as 18% at the Banks Pumping Plant and by as much as 31% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, *Boron*, Table Bo-22) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 9 would result in moderate increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 9 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 82% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 9 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 9 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 9, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 9 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on boron under Alternative 9 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 9 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 9 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 9, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (see Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3% relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 24). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 9, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 9 would result in increases in long-term average bromide concentrations at Buckley Cove (for the modeled drought period only), Emmaton, and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 20). With regard to bromide, Emmaton is a suitable source of raw drinking water on a seasonal basis. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 μg/L relative to Existing Conditions, particularly during October through December (Appendix 8E, *Bromide*, Figure 2). At Emmaton the predicted 50 μg/L exceedance frequency would increase only slightly from 82% under Existing Conditions to 86% under Alternative 9 (98% to 100% for the modeled drought period), and the predicted 100 μg/L exceedance frequency would increase from 72% under Existing Conditions to 81% under Alternative 9 (93% to 97% for the modeled drought period), indicative of very small changes during seasonally suitable periods of potential use. At Barker Slough, predicted long-term average bromide concentrations would increase from 51 μg/L to 61 μg/L (19% relative increase) for the modeled 16-year hydrologic period and 54 μg/L to 100 μg/L (88% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49%

under Existing Conditions to 41% under Alternative 9, but would increase from 55% to 80% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 16% under Alternative 9, and would increase from 0% to 42% during the drought period. At Buckley Cove, predicted long-term average bromide concentrations would remain the same (i.e., 259 μg/L), but would increase from 272 μg/L to 330 μg/L (21% relative increase) for the modeled drought period. At Buckley Cove, the predicted 50 μg/L exceedance frequency would not change (i.e., 100% exceedance), but the modeled 100 μg/L exceedance frequency would decrease from 100% under Existing Conditions to 90% under Alternative 9 (100% to 87% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative would be generally of similar magnitude to those previously described for the Existing Conditions comparison (Appendix 8E, *Bromide*, Table 20). Modeled long-term average bromide concentration at Emmaton would increase by as much as 36%, but change in 50 and 100 μg/L exceedance thresholds would be smaller than that described for the Existing Conditions comparison, indicative of very small changes during seasonally suitable periods of potential use. Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 23% (87% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Buckley Cove are predicted to increase by 7% (36% for the modeled drought period) relative to the No Action Alternative. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 9 operations.

At Barker Slough, modeled long-term average bromide concentrations for the various baseline conditions are very similar (≤4%) (Appendix 8E, *Bromide*, Table 20). Such similarity demonstrates that the modeled Alternative 9 change in bromide is almost entirely due to Alternative 9 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 9 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 21). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 9, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 23% under Alternative 9.Furthermore, concentrations predicted at Buckley Cove also differed. The EC to chloride and chloride to bromide relationship modeling approach predicted that concentrations at Buckley cove would decrease under Alternative 9 on both a long term basis and under the modeled drought period, relative to Existing Conditions and the No Action Alternative.

This is in contrast to the mass-balance approach presented above, which predicted an increase in concentrations under the drought period. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Buckley Cove are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the long-term average bromide concentration greater than 300 µg/L, would represent a substantial change in source water quality to the City of Stockton during a season of drought. Additionally, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. While the implications of such modeled changes in bromide concentrations at Buckley Cove and Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 9 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 140 µg/L (37% increase) at City of Antioch and would decrease from 150 µg/L to 146 µg/L (3% decrease) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 25). Changes would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 26). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 9 would lead to predicted improvements in long-term average bromide concentrations at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At Staten Island and Franks Tract, long-term average bromide concentrations would be predicted to decrease by 4–21% depending on baseline comparison, while at Rock Slough and Contra Costa PP No.1, long-term average bromide concentrations would be predicted to decrease by 40–45%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock

Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under Alternative 9, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with exception to the modeled drought period when compared the No Action Alternative. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 21% relative to Existing Conditions and 9% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 20). However, during the modeled drought period, long-term average bromide concentrations would increase by as much as 12% relative to the No Action Alternative. Exceedances of the 50 µg/L assessment threshold would remain virtually the same for both Banks and Jones, but exceedance of the 100 µg/L assessment threshold would decrease, from 100% to 81% at Banks and from 100% to 80% at Jones (100% to 77% for the modeled drought period at both Banks and Jones). Lower long-term average bromide concentrations at Banks and Jones would result in overall improvement in Export Service Areas water quality respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 21).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that

MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 9 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 9 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 9 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 9, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 9 would result in modeled increases in long-term average bromide concentration at Buckley Cove (for the drought period only), Barker Slough, and Emmaton. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 μg/L relative to Existing Conditions, rather than substantial increases during seasonally suitable periods of potential use. However, substantial increases in long-term average bromide at Barker Slough and Buckley Cove (i.e., vicinity of the City of Stockton's drinking water intake) during a season of drought could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 9, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 21% relative to

Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 9 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 9, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 9 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Buckley Cove (drought period only) and Barker Slough. At Buckley Cove, modeled long-term annual average concentrations of bromide would increase from 272 μg/L to 330 μg/L (21% relative increase) during the modeled drought period. At Barker Slough, modeled long-term annual average concentrations of bromide would increase from 54 μg/L to 100 μg/L (88% relative increase) for the modeled drought period. Furthermore, for Barker Slough the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 16% under Alternative 9 (0% to 42% for the modeled drought period). Substantial changes in long-term average bromide at these locations could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Buckley Cove during the drought period and at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant. However, there is no feasible mitigation available for identified impacts at Buckley Cove, which would remain significant and unavoidable during drought periods.

Implementation of Mitigation Measure WQ-5 along with a separate other commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate othercommitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 9 would be similar to conservation measures under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. As discussed for Alternative 1A, implementation of CM2–CM21 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM21 would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

In summary, implementation of CM2–CM21 under Alternative 9, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM21 are determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM21 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-62). Consequently, Alternative 9 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 9 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at some of the assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 20% compared to No Action Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 23% compared to No Action Alternative), Rock Slough (i.e., up to 20% compared to No Action Alternative), Franks Tract (i.e., up to 29% compared to No Action Alternative), Sacramento River at Emmaton (i.e., up to 25% compared to No Action Alternative), Sacramento River at Mallard Island (i.e., up to 6% compared to No Action Alternative), and North Bay Aqueduct at Barker Slough (i.e., up to 18% compared to No Action Alternative)(Appendix 8G, *Chloride*, Tables Cl-55 and Cl-56). Moreover, the direction and magnitude of predicted changes for Alternative 9 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 9, the modeled frequency of objective exceedance would increase from 7% of years under Existing Conditions and 0% under the No Action Alternative to 13% of years under Alternative 9 (Appendix 8G, *Chloride*, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 9, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 9 (Appendix 8G, *Chloride*, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for Existing Conditions to 0% under Alternative 9), thus indicating complete compliance with this objective would be achieved (Appendix 8G, *Chloride*, Table Cl-57 and Figure Cl-13). Compared to Existing Conditions, the frequency of exceedances would not change substantially at the San Joaquin River at Antioch (i.e., increase of 2% from 66% to 68%) or at Mallard Island (i.e., increase6% from 77% to 83%) and would be similar, or decrease, compared to the No Action Alternative (Appendix 8G, Table Cl-57), and there would be no substantial long-term degradation (Appendix 8G, Table Cl-59).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, *Chloride*, Tables Cl-58 and Cl-60). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1, Rock Slough, and Franks Tract locations, use of assimilative capacity would increase substantially for the months of February through July at Rock at the Contra Costa Canal at Pumping Plant #1 (i.e., maximum of 79% in March and April for the modeled drought period) and at the San Joaquin River in March and April (i.e., 13% and 14%, respectively). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would generally be similar compared to Existing Conditions and No Action Alternative, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14).

With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16). Although modeling of Alternative 9 assumed no operation of the Montezuma Slough Salinity Control Gates, the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in this sensitivity analysis, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 9, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 21% relative to Existing Conditions and 10% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-55). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-57). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Tables Cl-56 and Cl-58).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 9 would result in additional exceedances of the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Rock Slough and Franks Tract, and potentially measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No

Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 9 would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 9 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 9 operations would result in substantially reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1and Antioch, the potential exists for adverse effects on the municipal and industrial beneficial uses (see Mitigation Measure WQ-7; implementation of this measure along with a separate other commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 9 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Under Alternative 9, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM21) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM21 are considered to be not adverse.

CEQA Conclusion**:** Implementation of the CM2–CM21 for Alternative 9 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on DO under Alternative 9 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion**:** Effects of CM1 on DO under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 9, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on DO under Alternative 9 would be the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 9 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 9 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 9 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at San Andreas Landing and Jersey Point (Appendix 8H, *Electrical Conductivity*, Table EC-9).

The percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 18% under Alternative 9, and the percentage of days out of compliance would increase from 11% under Existing Conditions to 31% under Alternative 9.

The percentage of days the Jersey Point EC objective would be exceeded and the percentage of days out of compliance would increase from 0% under Existing Conditions to 2% under Alternative 9. The increase in percentage of days the San Andreas Landing EC objective would be exceeded and the percentage of days out of compliance would be <1%. These increases are minimal, and are not considered substantial, in light of overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, and S. Fork Mokelumne River at Terminous (an interior Delta location) would decrease from 1–33% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-20). In the Sacramento River at Emmaton, average EC would increase 22% for the entire period modeled and 36% during the drought period modeled. In the San Joaquin River at San Andreas Landing, average EC would increase 16% for the entire period modeled and 33% during the drought period modeled. Average EC in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would increase during all months (Appendix 8H, Table EC-20). In the San Joaquin River at Prisoners Point, average EC would increase 2% for the entire period modeled and 16% during the drought period modeled. Average EC at Prisoners Point would increase in September through December (Appendix

8H, Table EC-20). The western portion of the Delta—which is Clean Water Act section 303(d) listed as impaired due to elevated EC—would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at compliance locations in this region would increase relative to Existing Conditions (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. The comparison to Existing Conditions reflects changes in EC due to both Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percentage compliance with Bay-Delta WQCP EC objectives under Alternative 9 would be similar to that described above relative to Existing Conditions, except there would not be an increase in objective exceedance in the San Joaquin River at Jersey Point. For the entire period modeled, average EC levels would increase in the Sacramento River at Emmaton, and San Joaquin River at San Andreas Landing and Prisoners Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (22%); the increase at Emmaton would be 21% and at Prisoners Point would be 12% (Appendix 8H, *Electrical Conductivity*, Table EC-20). Similarly, during the drought period modeled, average EC would increase at these locations. The greatest average EC increase during the drought period modeled also would occur in the San Joaquin River at San Andreas Landing (33%); the average EC increase at Emmaton would be 24% and at Prisoners Point would be 25% (Appendix 8H, Table EC-20). The western portion of the Delta–which is Clean Water Act section 303(d) listed as impaired due to elevated EC–would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at this compliance location would increase relative to the No Action Alternative (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 9, relative to Existing Conditions, during the months of December through May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). In Montezuma Slough at National Steel during January and February, long-term average EC would increase 0.1–0.2 mS/cm (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.5–6.3 mS/cm, depending on the month, nearly doubling and tripling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 1.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 Scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to

Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H, Attachment 1, for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 9 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 9 would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 9.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 9 would decrease substantially on average: 56% for the entire period modeled and 62% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 53% for the entire period modeled and 60% during the drought period modeled (Appendix 8H, Table EC-20).

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 9 would also decrease on average, but to a lesser degree: 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 18% for the entire period modeled and 14% during the drought period modeled (Appendix 8H, Table EC-20).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 9 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 9 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 9 would result in lower long-term average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased long-term and drought period average EC levels that would occur in the San Joaquin River at San Andreas Landing (interior Delta), and the increased frequency of exceedance of EC objectives in the Sacramento River at Emmaton under Alternative 9, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increased frequency of exceedance of the Bay-Delta WQCP objectives and long-term average EC levels at this compliance location could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The increases in long-term average EC levels that could occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects. Implementation of this measure along with a separate other commitment as set forth in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, relating to the potential EC-related changes would reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 9 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the

EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 9 would result in an12% increase in the frequency with which the Bay-Delta WQCP EC objectives are exceeded at Emmaton (western Delta), a 2% increase in the frequency with which fish and wildlife EC objectives are exceeded in the San Joaquin River at Jersey Point for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 22% for the entire period modeled and 36% during the drought period modeled, and EC levels at San Andreas Landing would increase by 16% for the entire period modeled and 33% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 9 could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate other commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less-than-significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on EC under Alternative 9 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, *Mercury*, Figures I-10 through I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 9 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 9.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 9 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 10.2% at Old River at Rock Slough, and a 10.1% reduction relative to the No Action Alternative at that location (Figures 8-53a and 8-54a). Similarly, increases in long term annual average methylmercury concentration are expected to be greatest (approximately 30%) at the Contra Costa Pumping Plant as compared to Existing Conditions and the No Action Alternative (Appendix 8I, *Mercury*, Figure I-9, Table I-6). The concentration of methylmercury is estimated to be 0.163 ng/L at that location, which is greater than Existing Conditions (0.121 ng/L) and the No Action Alternative (0.122 ng/L). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show some substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest change in exceedance quotients are expected for Old River at Rock Slough with changes of 66% over Existing Conditions, and 59% over the No Action Alternative (Figures 8-55a and 8-55b; Appendix 8I, *Mercury*, Table I-16b). The Contra Costa Pumping Plant values shows a 62% increase in fish tissue concentrations over Existing Conditions, and 59% over the No Action Alternative (Appendix 8I, Table I-16b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 9 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, FiguresI-7 and I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53a and 8-54a). Bass tissue mercury concentrations are also improved under Alternative 9, relative to Existing Conditions and the No Action Alternative (Figures 8-55a and 8-55b; Appendix 8I, Tables I-16a and I-16b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 9 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for Alternative 9 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 9 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 9 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Some habitat restoration activities under Alternative 9 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under

Alternative 9 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 9 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 9.

CM12 addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2-CM21 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 9 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 9, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (see Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Appendix 8J, *Nitrate*, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 9.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Tables 31 and 32). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to

0.96, 1.32, and 1.38 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant#1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Appendix 8D, *Source Water Fingerprinting Results*). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 9% on a long-term average basis (Appendix 8J, Table 33). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 10%, and averaged approximately 6% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Appendix 8J, Table 33).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 9, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 9, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 9, the increase is expected to be greater under Existing Conditions than for Alternative 9 due to the upgrades that are assumed under Alternative 9.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Appendix 8J, *Nitrate*, Table 31 and 32). No additional exceedances of the MCL are anticipated (Appendix 8J, Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Appendix 8J, Table 33).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping

Plant #1 (all >100% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants was negligible for all months.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on nitrate under Alternative 9 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 9, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 9, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.6–1.0 mg/L would be predicted (≤28% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, *Organic Carbon,* DOC Table 10). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 99% under the Alternative 9 (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 44% (32% to 67% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under Alternative 9 (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 65% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 9 operations (including use of operable barriers and numerous other components of Operational Scenario G) and climate change/sea level rise.

In comparison, Alternative 9 relative to the No Action Alternative would generally result in a magnitude of change similar to that discussed for the comparison to Existing Conditions. Maximum increases of 0.6–0.9 mg/L DOC (i.e., ≤24%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon,* DOC Table 10). Threshold concentration exceedance frequency trends would also be similar to those discussed for the Existing Conditions comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 39% (42% to 50% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 9 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 9, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 9 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough and Staten Island, as well Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough and Staten Island would decrease <0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 9, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 10). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 39% under Alternative 9 (100% to 32% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 9, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 0.9 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 9 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 9 would result in substantial increases (i.e., 0.6–1.0 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 9 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to Existing Conditions, long-term average DOC concentrations would decrease by as much as 1.8 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤10% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 9 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 9, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 9 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.6–1.0 mg/L, equivalent to ≤28% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No. 1. In particular, under Alternative 9, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the Alternative 6A discussion.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 9 would be similar to conservation measures under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Therefore, effects on DOC resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 9 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Effects of CM4–CM7 and CM10 on DOC under Alternative 9 are similar to those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. Mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments, AMMs, and CMs*, a separate other commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 9 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 9 would be the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM21

***NEPA Effects*:** Effects of CM2–CM21 on pathogens under Alternative 9 would be the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 9 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 9, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and winter (Appendix 8L, *Pesticides*, Tables 1–4). On the Feather River, average flow rates would increase by as much as 10% during the summer, but would decrease by as much as 5% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 7% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 9, the distribution and mixing of Delta source waters would change. Percentage change in monthly average source water fraction was evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 9 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, *Source Water Fingerprinting Results*). At Antioch, San

Joaquin River source water fractions would increase by 12–15% from October through May (11–14% from November through April for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 25–57% for the entire calendar year of January through December (11–52% for October through July of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 35–80% (25–78% for the modeled drought period) for the entire calendar year of January through December. In addition, Sacramento River fractions would increase greater than 10% at Staten Island and Buckley Cove (not including Banks and Jones). At Staten Island, Sacramento River fractions would increase by 16% in April and 20% in May (13–15% from February through April of the modeled drought period). These changes at Staten Island are not considered substantial. At Buckley Cove, however, Sacramento source water fraction would increase between 36–72% (46–73% for the drought period) for the entire calendar year of January through December. Although a considerable change, this change in source water fraction at Buckley Cove would balance through a nearly equivalent decrease in San Joaquin River water. Delta agricultural fractions would not increase greater than 8% at any assessment location.

Relative to Existing Conditions, increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between October and June (>50% for November and December during the modeled drought period), and would be greater than 50%, and as much as 86% for the entire calendar year at Rock Slough and Contra Costa PP No. 1 (greater than 50% and as high as 80% for October through June of the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in winter and early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions (Appendix 8D, *Source Water Fingerprinting Results*). Relative to the No Action Alternative the similar magnitude increase in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially increase the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 9, Sacramento River source water fractions would increase at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, *Source Water Fingerprinting Results*). At Banks pumping plant, Sacramento source water fractions would generally increase from 12–38% for February through June (12–37% for February through June of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 7–54% for the entire calendar year (14–69% for September through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 9 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 9, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 9 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 9 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 9. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for the calendar year such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 9 would be similar to conservation measures under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on pesticides resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2–CM21 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*:** Effects of CM2–CM21 on pesticides under Alternative 9 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 9, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 9, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 9, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 9 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects**:** Effects of CM2–CM21 on phosphorus levels in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM21 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 9, which are considered to be not adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2–CM21 not attributable to hydrodynamics, such as additional loading of a constituent to the

Delta, are discussed within the impact header for CM2–CM21. See Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 9, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-19 and M-29 for most biota (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24, provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 9 would result in small to moderate changes in average selenium concentrations in water at modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.21 µg/L for the entire period modeled (1976–1991). These increases in selenium concentrations in water would result in reductions in available assimilative capacity of 1–19%, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water for Alternative 9 (range 0.09–0.37 µg/L) would be similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and all would be below the USEPA draft water quality criterion of 1.3 µg/L Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would generally result in small changes (less than 4%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, Table M-29). Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 35% relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.4 mg/kg dry weight). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 17% in all years (from about 4.4 to 5.2 mg/kg dry weight) (Appendix 8M, *Selenium*, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by about 35% at Antioch and 17% at Mallard Island. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Appendix 8M, Table M-32) and for all years at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from 0.94 to 1.3 at Antioch) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at Antioch (where quotient increases from 0.85 to 1.2), unlike Existing Conditions and the No Action Alternative (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota are attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on “fixed” K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 8-60a shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 9 would be greater in the South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 9 in the South Delta are expected to increase by more than 18 days (Table 8-60a) and by more than 16 days relative to the No Action Alternative. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cfs in June 1998 to 12,251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years (see Appendix 8M, *Selenium*). If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 8-60a, the overall increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions, and 1 day relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in small changes in selenium concentrations throughout the Delta for most biota (less than 4%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would only exceed the lower benchmark for both western Delta locations for all years and drought years, indicating a low potential for effects. Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increase for Alternative 9 are high enough that they may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 9 would result in moderate decreases in average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 5–12%, relative to the 1.3 µg/L USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, the long-term average selenium concentrations in water for Alternative 9 (range 0.16–0.17 µg/L) would be well below the USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in small changes (less than 3%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a through 8-64b; Appendix 8M, Table M-29). Concentrations in biota would not exceed any selenium benchmarks for Alternative 9 (Figures 8-61a through 8-64b).

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 9 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an average of 26%, which may represent a measurable increase in the environment. These potentially measurable increases represent an adverse impact.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010d) and State Water Board (2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 9 would result in small changes in selenium concentrations in water or most biota through the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 9 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an average of 26%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are exceeded, these potentially measurable increases represent a potential impact to fish and wildlife beneficial uses.

The assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 9 would cause no increase in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria; however, significant impacts on some beneficial uses of waters in the Delta could occur because uptake of selenium from water to biota would be expected to increase above potential effects levels at some locations, and in the western Delta where concentrations in sturgeon exceed both low and high toxicity benchmarks under Existing Conditions, uptake of selenium from water to sturgeon may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 9 would be the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, *Source Water Fingerprinting Results*). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 9 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 9, relative to Existing Conditions and the No Action Alternative. As such, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 9, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 9 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 9.

The assessment of the Alternative 9 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 9 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM21

NEPA Effects: CM2–CM21 under Alternative 9 would be similar to conservation measures under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on trace metals resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. Implementation of CM2–CM21 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM21under Alternative 9, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM21 under Alternative 9 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on TSS and turbidity under Alternative 9 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion: Effects of CM1 on TSS and turbidity under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 9, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM21

NEPA Effects: Effects of CM2–CM21 on TSS and turbidity under Alternative 9 would be the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM21 is determined to not be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 9 would be similar to conservation measures proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM21 would be similar to those previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM21)

The construction activities necessary to implement new conveyance features for CM1 under Alternative 9 would involve substantially different locations and types of construction activity to those discussed for Alternative 1A. In particular, the construction of permanent operable gates, locks, new levees, channel improvements and enlargement within Delta channels would involve considerable in-channel dredging and in-water facility construction activity. However, construction techniques for many features of the conveyance system within the Delta would be similar. Landside construction of water conveyance facilities under Alternative 9 would involve an array of intakes, pumping plants, pipelines, culvert siphons, canals, borrow areas, and other facilities. The remainder of the facilities constructed under Alternative 9, including CM2–CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: he types of potential construction-related materials used, constituent discharges, and related water quality effects associated with implementation of CM1 under Alternative 9 would be similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM21 would be essentially identical. However, given the substantial differences in the conveyance features under CM1, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, the extensive in-water dredging, and construction of channel enlargements, operable barriers, culvert siphons, and canal segments under Alternative 9 would result in potential direct turbidity discharges and sediment resuspension. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments, AMMs, and CMs,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 9 would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to Existing Conditions, Alternative 9 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 9 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 9, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 9 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 9, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, water exported from the Delta to the SWP/CVP Export Service Areas will consist of a mixture of water from the south Delta that is affected by *Microcystis* and Sacramento River water diverted from the north Delta that is unaffected by *Microcystis*. Sacramento River water will be conveyed through existing Delta channels under Alternative 9, in contrast to pipelines or tunnels which will be constructed to convey this water under Alternative 1A. Under Alternative 9, Delta channels, gates and barriers will be operated and maintained to convey Sacramento River water to the south Delta pump intakes in manner to maintain the water quality of this source water. Thus, it is expected that diverted Sacramento River water will remain relatively unaffected by *Microcystis* until it mixes with *Microcystis*-affected water from the south Delta at Banks and Jones pumping plants. For the same reasons described for Alternative 1A, it cannot be determined whether operations and maintenance under Alternative 9, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 9, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 9 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the affected environment under Alternative 9 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 9 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 9 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under Alternative 9, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 9 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 9 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 9, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 9. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 9, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 9. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 9, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 9 would be the same as those discussed for Alternative 1A. In summary, implementation of CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters. Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above). The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32a. The effectiveness of the mitigation measure to result in feasible measures for reducing water quality effects is uncertain. CM3 and CM5–CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21 on *Microcystis* under Alternative 9 would be the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans.Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Implementation of Mitigation Measure WQ-32a may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 9 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- DO
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, DO, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 9 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the AGR AGR and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in San Francisco Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay.

While effects of Alternative 9 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 9 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 17%, relative to Existing Conditions, and increase by 21%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 9 would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 9 is estimated to increase by 5%, relative to Existing Conditions, and there would be no change relative to the No Action Alternative (Appendix 8O, Table O-1). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, *San Francisco Bay Analysis*, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 9. Mercury load to the Bay is estimated to increase by 8 kg/year (3%), relative to Existing Conditions, and 5 kg/year (2%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.14 kg/year (4%), relative to Existing Conditions, and increase by 0.05 kg/year (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 268 kg/year, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/year. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2006; David et al. 2009).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 9 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 9, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 16%, relative to Existing Conditions, and increase by 13%, relative to the No Action Alternative (Appendix 8O, *San Francisco Bay Analysis*, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 9, the long-term average total selenium concentration of the North Bay is estimated to be 0.15 μg/L and the dissolved selenium concentration is estimated to be 0.13 μg/L, which would be a 0.02 μg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 μg/L developed by Presser and Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 9, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1A–5, but still low (0.02 μg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (San Francisco Estuary Institute 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 9 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 9 could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 9, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 9 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 9 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the

Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 17% decrease in total nitrogen load and 5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (8 kg/year; 3%) and methylmercury load (0.14 kg/year; 4%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

In regard to selenium, the estimated increase in selenium load would be 16% and the estimated increase in dissolved selenium concentrations would be 0.02 µg/L. Though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus, the increase in selenium load may make the CWA section 303(d) selenium impairment measurably worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant.*AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.4 Effects and Mitigation Approaches—Alternatives 4A, 2D, and 5A

8.3.4.1 No Action Alternative Early Long-Term

Discussion of water quality impacts of the No Action Alternative (ELT) was first provided in the Partially Recirculated Draft Environmental Impact Report/Supplementatl Draft Environmental Impact Statement (RDEIR/SDEIS). The water quality assessments in the RDEIR/SDEIS for boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Services Areas utilized results from water quality modeling that assumed no implementation of Yolo Bypass improvements or tidal habitat restoration. The analysis of effects of the No Action Alternative (ELT) presented herein on boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Service Areas is based on revised modeling, which assumed implementation of Yolo Bypass improvements, but no tidal habitat restoration. The water quality impact conclusions for the No Action Alternative (ELT) in this Final EIR/EIS remain the same as those presented in the RDEIR/SDEIS. The revisions to the assessment are in the presentation of modeled changes in concentrations, water quality criteria/objective exceedances, and use of assimilative capacity.

As described in Section Chapter 3, Section 3.5.17, *No Action Alternative ELT*, 8,000 acres of tidal habitat restoration areas would be developed under the No Action Alternative (ELT). In general, the significance of this relative to the modeling results that do not reflect this restoration area is the assessment of bromide, chloride and EC for the No Action Alternative (ELT), relative to Existing Conditions, may underestimate increases in bromide, EC, and chloride that could occur, particularly in the west Delta. Nevertheless, there is some uncertainty in the results of all quantitative assessments that refer to modeling results, due to the differing assumptions used in the modeling and the description of the No Action Alternative (ELT).

Note that the numbering of water quality impacts for the No Action Alternative (ELT), presented below, is consistent with the numbering of impacts for Alternatives 4A, 2D, and 5A, For the project alternatives, two numbered impacts are provided for each constituent or constituent class, one for impacts due to water conveyance facilities operations and maintenance and the other for impacts due to Environmental Commitments. For the No Action Alternative (ELT), only discussion of impacts due to water conveyance facilities operations and maintenance is applicable. Therefore, only one numbered impact for each constituent or constituent-class is provided for the No Action Alternative (ELT), consistent with the numbering for Alternatives 4A, 2D, and 5A water conveyance facilities operations and maintenance impacts.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on ammonia levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT) discussed in Section 8.3.3.1. This is because factors which affect ammonia levels in these areas would be similar at the ELT and LLT timeframes. The Sacramento Regional County Sanitation District will have completed modifications to the Sacramento Regional Wastewater Treatment Plant (SRWTP) in the ELT that will substantially reduce ammonia in the treated wastewater discharge and thus substantially lower concentrations of ammonia in the Sacramento River downstream of the SRWTP relative to Existing Conditions. A substantial decrease in Sacramento River ammonia concentrations is expected to decrease ammonia concentrations for all areas that are influenced by Sacramento River water, which includes various locations in the Delta and at Jones and Banks Pumping Plants where Delta water is exported to the SWP/CVP Export Service Areas. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged relative to Existing Conditions. Based on these factors and for the reasons described for the No Action Alternative (LLT) in Section 8.3.3.1, the effects on ammonia from implementing the No Action Alternative (ELT) would not be adverse.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on ammonia levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT). This is because factors that would directly affect ammonia levels in the surface waters of these areas are expected to be similar in the ELT and LLT. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered less than significant.

Impact WQ-3: Effects on Boron Concentrations Resulting from Existing Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on boron concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for the No Action Alternative (LLT) in Section 8.3.3.1. There would be no expected change to the sources of boron in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions in association with climate change and increased water demands. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 0.5% relative to the Existing Conditions (Appendix 8F, *Boron*, Table Bo-32). Consequently, the increases in lower San Joaquin River boron levels under the No Action Alternative (ELT), relative to Existing Conditions, would be small and not adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to Existing Conditions, the No Action Alternative (ELT) would result in similar or decreased long-term annual average boron concentrations at all of the Delta assessment locations for the 16-year period modeled (i.e., 1976–1991) (Appendix 8F, *Boron*, Table Bo-24). For the drought year period modeled (i.e., 1987–1991), the No Action Alternative (ELT) would result in increased annual average concentrations at Franks Tract (1% increase), Old River at Rock Slough (1% increase), and the Sacramento River at Emmaton (3% increase) relative to Existing Conditions.

With respect to the 2,000 μg/L EPA drinking water human health advisory objective (i.e., for children) and agricultural objective of 500 μg/L contained in the San Francisco Bay Water Board (Region 2) Basin Plan, the long-term annual average boron concentrations, for either the 16-year period or drought period modeled, are low and would not exceed these objectives at any of the eleven Delta assessment locations (Appendix 8F, *Boron*, Table Bo-3C). The maximum long-term average concentration of about 423 μg/L in the Sacramento River at Mallard Island under the No Action Alternative (ELT) represents a slight decrease from the Existing Conditions. Accordingly, the long-term assimilative capacity with respect to both objectives would not change substantially, thus boron levels that may occur under the No Action Alternative (ELT), relative to Existing Conditions, would not be expected to adversely affect municipal water supply beneficial uses of the Delta.

SWP/CVP Export Service Areas

Under the No Action Alternative (ELT), a relatively small increase would occur in the long-term average boron concentration at the Jones Pumping Plant, relative to the Existing Conditions (i.e., up to 1% for both the 16-year and drought period modeled) and a small decrease would occur at the Banks Pumping Plant (i.e., reduced 1%) (Appendix 8F, *Boron*, Table Bo-24). The small change in boron concentrations exported from the Delta would not be expected to measurably affect boron levels in the lower San Joaquin River at Vernalis or the existing CWA Section 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

In summary, the effects of additional future climate change/sea level rise under the No Action Alternative (ELT) condition would result in relatively small changes in long-term average boron concentrations in the lower San Joaquin River and several Delta locations. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality. The changes to long-term and monthly average boron concentrations at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service areas under the No Action Alternative (ELT) would be similar or lower in magnitude relative to effects described for the No Action Alternative (LLT) in Section 8.3.3.1.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on boron levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT). This is because factors that would directly affect boron levels in the surface waters of these areas are expected to be similar at the ELT and LLT timeframes. As such, the No Action Alternative (ELT) is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because boron concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Additionally, the changes in long-term average boron concentrations in exported water would not result in further degradation or the existing impairment and CWA Section 303(d) listing of boron in the lower San Joaquin River for the agricultural water supply beneficial use to be discernibly worse. Boron is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative (ELT) would not result in adverse boron bioaccumulation effects to aquatic life or humans. Based on these findings, this impact is determined to be less than significant.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on bromide concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for the No Action Alternative (LLT) in Section 8.3.3.1, because factors affecting bromide concentrations in these water bodies would be the same in the ELT. There would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions in association with climate change and increased water demands, but the associated change would less than in the LLT, and any associated bromide increase would not be substantial, as described for the LLT (Appendix 8E, *Bromide*, Table 24). Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, the No Action Alternative (ELT) would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the San Joaquin River, the eastside tributaries, or their associated reservoirs upstream of the Delta due to changes in bromide concentrations.

Delta

Estimates of bromide concentrations at Delta assessment locations were generated using a mass balance approach, and using relationships between EC and chloride and between chloride and bromide and DSM2 EC output. See Section 8.3.1.3 for more information regarding these modeling approaches. The assessment below identifies changes in bromide at Delta assessment locations based on both approaches.

Relative to Existing Conditions, the No Action Alternative (ELT) would result in small decreases or essentially no change in long-term average bromide concentrations at all modeled Delta assessment locations (Appendix 8E, *Bromide*, Tables 22 and 23). Long-term average concentrations of seawater-derived constituents generally decrease under the No Action Alternative (ELT) relative to Existing Conditions because the No Action Alternative (ELT) includes Fall X2 operations, while Existing Conditions does not (Appendices 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Condition*, and 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative (ELT), and not in Existing Conditions, the effect of Fall X2 on bromide is generally greater than sea level rise.

The modeled frequency with which bromide concentrations would exceed bromide thresholds would change only slightly at Delta assessment locations (Appendix 8E, *Bromide*, Table 22). Small increases in exceedance of the CALFED Drinking Water Program long-term goal of 50 µg/L would occur at the Mokelumne River at Staten Island (4% increase), in the Sacramento River at Emmaton (2% increase) and in Old River at Rock Slough (1% increase). Small increases in exceedance of 100 µg/L, which is the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts, would occur at some Delta interior and western Delta assessment locations. In the Delta interior at Rock Slough and Franks Tract, the frequency of exceeding 100 µg/L would increase by up to 2%. In the western Delta, the frequency of exceeding 100 µg/L would increase by up to 5% at Emmaton, by up to 2% at Antioch and up to 1% at Mallard Island. As described for the No Action Alternative (LLT) in Section 8.3.3.1, the resulting bromide concentrations would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8E, *Bromide*, Table 23).

SWP/CVP Export Service Areas

Under the No Action Alternative (ELT), long-term average bromide concentrations at the Banks and Jones Pumping Plants would decrease by as much as 6% relative to Existing Conditions (Appendix 8E, *Bromide*, Table 22), based on the mass balance modeling results. The frequency with which bromide would exceed bromide concentration thresholds at the Banks and Jones Pumping Plants, relative to Existing Conditions, would remain unchanged (Appendix 8E, *Bromide*, Table 22). Consequently water exported into the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regard to bromide under the No Action Alternative (ELT), relative to Existing Conditions. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide were consistent these results, and assessment of bromide using these modeling results leads to the same conclusions as presented for the mass balance approach (Appendix 8E, *Bromide*, Table 23).

In summary, the effects of additional future climate change/sea level rise under the No Action Alternative (ELT) condition would result in relatively small changes in long-term average bromide concentrations in the lower San Joaquin River and several Delta locations. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality. The changes to long-term and monthly average boron concentrations at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service areas under the No Action Alternative (ELT) would be similar or lower in magnitude relative to effects described for the No Action Alternative (LLT) in Section 8.3.3.1.

Maintenance of SWP and CVP facilities under the No Action Alternative (ELT) would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** While greater water demands under the No Action Alternative (ELT) would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the San Joaquin River, the eastside tributaries, and the various reservoirs of the related watersheds, as described for the No Action Alternative (LLT).

Relative to Existing Conditions, the No Action Alternative (ELT) would result in small decreases or essentially no change in average bromide concentrations at all modeled Delta assessment locations. Small increases in bromide threshold exceedances would occur at some Delta interior and western Delta assessment locations, including the Mokelumen River at Staten Island, Rock Slough, Franks Tract, Emmaton, Antioch and Mallard Island, but the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones Pumping Plants Average bromide concentrations at the Banks and Jones Pumping Plants are predicted to decrease by as much as 6% relative to Existing Conditions while exceedance of bromide concentration thresholds at the Banks and Jones Pumping Plants would remain unchanged.

Based on the above, the No Action Alternative (ELT) would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. The No Action Alternative (ELT) would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 µg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 µg/L assessment threshold concentration would be 5% or less at all locations assessed, which is considered to be less-than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the No Action Alternative (ELT) would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not CWA Section 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on chloride concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for the No Action Alternative in Section 8.3.3.1, because factors affecting chloride concentrations in these water bodies would be the same in the early long-term timeframe. There would be no expected change to the sources of chloride in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions in association with climate change and increased water demands, but the associated change would less than under the LLT, and any associated chloride increase would be less than substantial, as described for the LLT. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, the No Action Alternative (ELT) would not be expected to cause exceedance of chloride objectives or substantially degrade water quality with respect to chloride and thus would not adversely affect any beneficial uses of the Sacramento River, the San Joaquin River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Delta

Estimates of chloride concentrations at Delta assessment locations were generated using a mass balance approach and EC chloride relationships and DSM2 EC output. See Section 8.3.1.3 for more information regarding these modeling approaches. The assessment below identifies changes in chloride at Delta assessment locations based on both approaches.

Relative to Existing Conditions, the mass balance modeling predicts that the No Action Alternative (ELT) would result in similar, or in small decreases in, long-term average chloride concentrations for the 16-year period modeled (i.e., 1976–1991) at all Delta assessment locations except the Sacramento River at Emmaton (Appendix 8G, *Chloride*, Table Cl-65). In the Sacramento River at Emmaton, there would be a 2 mg/L (<1%) decrease in the long-term average chloride concentration, but a 45 mg/L (9%) increase in the drought period modeled (i.e., 1987–1991) chloride concentration. Long-term average concentrations of seawater-derived constituents would generally decrease under the No Action Alternative (ELT) relative to Existing Conditions because the No Action Alternative (ELT) includes Fall X2, while Existing Conditions does not (Appendices 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Condition*, and 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Therefore, even though sea level rise is included in the No Action Alternative (ELT), and not in Existing Conditions, the effect of Fall X2 on chloride is generally greater than sea level rise.

The comparison to Existing Conditions reflects changes in chloride due to both increased demands and changed hydrology and Delta hydrodynamic conditions associated with climate change and sea level rise. The following outlines the modeled chloride changes relative to the applicable objectives and effects on beneficial uses in Delta waters.

Municipal and Industrial Beneficial Uses Relative to Existing Conditions

Estimates of chloride concentrations generated using EC chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective would be exceeded for the 16-year period modeled. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at Antioch or Contra Costa Pumping Plant #1. For the No Action Alternative (ELT), the frequency of objective exceedance would decrease relative to Existing Conditions. The frequency of exceedance of the 150 mg/L objective is predicted to be 7% of years under Existing Conditions and 0% under the No Action Alternative (Appendix 8G, *Chloride*, Table Cl-64).

Evaluation of the 250 mg/L Bay-Delta WQCP objective for chloride utilized results from both the mass balance approach and EC chloride relationships. The basis for the evaluation was the predicted number of days the objective would be exceeded for the modeled 16-year period.

Based on the mass-balance approach, there would be an increased frequency of exceedance of the 250 mg/L objective under the No Action Alternative (ELT), relative to Existing Conditions, in the Sacramento River at Emmaton, the San Joaquin River at Antioch, and the Sacramento River at Mallard Island. At Emmaton, the frequency of objective exceedance would increase from 55% under Existing Conditions to 60% under the alternative during the drought period; when the entire modeled period is considered, there would be a decrease in the frequency of objective exceedance. At Antioch, the frequency of objective exceedance would increase from 66% to 70% for the entire period modeled, and from 82% to 85% during the drought period modeled. In the Sacramento River at Mallard Island, the frequency of objective exceedance would increase from 85% to 86% for the entire period modeled (Appendix 8G, *Chloride*, Table Cl-81). These changes are small enough that they may be within the uncertainty of the modeling approach.

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For the No Action Alternative (ELT), the modeled frequency of objective exceedance would increase, from 6% of modeled days under Existing Conditions, to 8% of modeled days under the No Action Alternative (ELT) (Appendix 8G, *Chloride*, Table Cl-63).

The mass balance results also indicate reduced assimilative capacity with respect to the 250 mg/L objective during certain months and locations. At Franks Tract, Old River at Rock Slough, and Sacramento River at Emmaton, there would be a reduction in assimilative capacity in January of 48-100% during the drought period modeled. Use of assimilative capacity would be 67% over the 16 year period modeled in June in the Sacramento River at Emmaton. In the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in March and April of up to 19% for the 16-year period modeled, and a 49% reduction during the drought period modeled (Appendix 8G, *Chloride*, Table Cl-67). Assimilative capacity at the Contra Costa Pumping Plant #1 also would be reduced, in February and March, by up to 13%, and by 75% during January of the drought period modeled.

When utilizing the EC-chloride relationship to model chloride concentrations for the 16-year period, trends in frequency of exceedance of the 250 mg/L objective and use of assimilative capacity are similar to those discussed above for the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-68 and Cl-82).

Based on the additional predicted seasonal and annual exceedances of Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation and use of assimilative capacity, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at Antioch, through reduced opportunity for diversion of water with acceptable chloride levels.

CWA Section 303(d) Listed Water Bodies–Relative to Existing Conditions

Tom Paine Slough in the southern Delta is on the state's CWA Section 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough, would be well below the MCL and generally would be similar to Existing Conditions (Appendix 8G, *Chloride*, Figure Cl-17).

Suisun Marsh also is on the state's CWA Section 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. The Sacramento River at Mallard Island, Sacramento River at Collinsville, and Montezuma Slough at Beldon's Landing within the marsh are DSM2-modeled locations representative of source water quality conditions for the marsh that is supported by inflowing flood tide waters from the west, and ebb tide flows of Sacramento River water into Montezuma Slough through the Suisun Marsh Salinity Control Gates located near Collinsville. Long-term average chloride concentrations at the Sacramento River at the Mallard Island for the 16-year period modeled would decrease by 100 mg/L (4%) relative to Existing Conditions (Appendix 8G, *Chloride*, Table Cl-65). The plots of monthly average chloride concentrations for the Sacramento River at Collinsville (Appendix 8G, *Chloride*, Figure Cl-19) and Montezuma Slough at Beldon's Landing (Appendix 8G, *Chloride*, Figure Cl-20) for the 16-year period modeled indicate that, relative to Existing Conditions, chloride concentrations would be similar or lower during the months of October through May. Consequently, chloride concentrations at Tom Paine Slough and Suisun Marsh would not be further degraded on a long-term basis or adversely affect necessary actions to reduce chloride loading for any TMDLs developed.

SWP/CVP Export Service Areas

Under the No Action Alternative (ELT), long-term average chloride concentrations at the Banks and Jones Pumping Plants would decrease by 6% and 5%, respectively, relative to Existing Conditions for the 16-year period modeled, based on mass-balance modeling results (Appendix 8G, *Chloride*, Table Cl-65). However, the frequency of objective exceedance would increase at both pumping plants, relative to Existing Conditions, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-81). Results of the modeling approach which utilized a EC chloride relationship are consistent these results, and assessment of chloride using these modeling output results in the same conclusions as for the mass-balance approach (Appendix 8G, *Chloride*, Tables Cl-66 and Cl-82).

Maintenance of SWP and CVP facilities under the No Action Alternative (ELT) would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any beneficial uses would be adversely affected anywhere in the affected environment.

***CEQA Conclusion*:** Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the No Action Alternative (ELT), relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the No Action Alternative (ELT) would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

It is expected there would be changes in Delta chloride levels in response to a shift in the Delta source water percentages under the No Action Alternative (ELT) or some degradation of these water bodies. There would be an increase in the frequency of exceedance of the daily average 250 mg/L chloride objective applicable at Contra Costa Pumping Plant #1 from 6% of modeled days to under Existing Conditions to 8% of modeled days under the No Action Alternative (ELT). Relative to Existing Conditions, the No Action Alternative (ELT) also would result in increased chloride concentrations such that frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase in the San Joaquin River at Antioch (by 4%) and in the Sacramento River at Mallard Island (by 1%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. With respect to CWA Section 303(d) listings, the similar average chloride concentrations would not cause further degradation on a long-term basis that would adversely affect necessary actions to reduce chloride loading for any TMDLs developed for Tom Paine Slough and Suisun Marsh.

Long-term average chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative (ELT) would not result in adverse chloride bioaccumulation effects to aquatic life or humans.

Based on these findings, this impact is determined to be significant due to increased chloride concentrations and objective exceedances, and additional long-term degradation, in the western Delta and associated effects on the municipal and industrial water supply beneficial uses.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on DO levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because the factors that would affect DO levels in the surface waters of these areas would be the same in the ELT as in the LLT. For the reasons described for the No Action Alternative (LLT) in Section 8.3.3.1, the effects on DO from implementing the No Action Alternative (ELT) is determined to not be adverse.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on DO levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT). This is because the factors that would affect DO levels in the surface waters of these areas would be similar in the ELT and LLT. There would be no substantial, and likely no measurable, long-term change in DO levels Upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would adversely affect beneficial uses. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be expected to be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels are expected, greater degradation and impairment of these areas is not expected to occur. Based on these findings, this impact is considered less than significant.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on EC levels in reservoirs and rivers upstream of the Delta would be similar to those effects described for the No Action Alternative in Section 8.3.3.1. The extent of new urban growth would be less in the early long-term, thus discharges of EC-elevating parameters in runoff and wastewater discharges to water bodies upstream of the Delta would be expected to be less than in the LLT. However, the state is regulating point source discharges of EC-related parameters and implementing a program to further loading of EC-related parameters to tributaries. Based on these considerations, and those described in Section 8.3.3.1, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

For the San Joaquin River, increases in EC levels under the No Action Alternative (ELT) could occur, but would be slightly less than those described for No Action Alternative (LLT) in Section 8.3.3.1. This is because the effects of climate change on flows, which could affect dilution of high EC discharges, would be less in the early long-term. The implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis are expected to contribute to improved EC levels. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Similar to the No Action Alternative (LLT), the No Action Alternative (ELT) would result in a fewer number of days when interior and southern Bay-Delta WQCP compliance locations would exceed EC objectives or be out of compliance with the EC objectives (Appendix 8H, *Electrical Conductivity*, Table EC-26). However, western Delta locations—Sacramento River at Emmaton (agricultural objective) and San Joaquin River at Jersey Point (fish and wildlife objective)—would experience an increased frequency of exceedance of EC objectives, where sea level rise and increased water demands would combine to cause increases in EC, relative to Existing Conditions (Appendix 8H, *Electrical Conductivity*, Table EC-26). The number of days the EC levels would exceed objectives and be out of compliance at these locations would be less at the ELT than the LLT. Further, average EC levels at western, interior, and southern Delta compliance locations, other than the Sacramento River at Emmaton, would decrease relative to Existing Conditions. The increase in exceedances at Jersey Point would be from 0% under Existing Conditions to 3% under No Action Alternative (ELT), which represents a very small increase for this objective. Further discussion of EC increases relative to this objective can be found in Appendix 8H, *Electrical Conductivity*, Attachment 2. Average EC at Emmaton would increase by 1% for the entire modeled period (1976–1991) and 10% for the drought period modeled (1987–1991), relative to Existing Conditions (Appendix 8H, *Electrical Conductivity*, Table EC-28), similar to increases that would occur in the LLT. Given that the western Delta is CWA Section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and average EC levels at Emmaton during the drought period has the potential to contribute to additional impairment and adversely affect beneficial uses.

Also similar to the No Action Alternative (LLT), relative to Existing Conditions, the No Action Alternative (ELT) would result in increased average EC in Suisun Marsh during the months of February through May. The average EC increases would be lower in magnitude than in the LLT, ranging from 0.1–0.4 mS/cm, depending on the location and month (Appendix 8H, *Electrical Conductivity*, Tables EC-32 through EC-36). For the reasons described for the No Action Alternative in Section 8.3.3.1, the small increase in EC relative to Existing Conditions would not be expected to adversely affect beneficial uses of Suisun Marsh under the No Action Alternative (ELT). While Suisun Marsh is CWA Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) relative to the substantial fluctuations in daily EC in the marsh channels as to not be measurable, and beneficial uses would not be adversely affected.

SWP/CVP Export Service Areas

The frequency of exceedance of EC objectives at the Banks and Jones Pumping Plants under the No Action Alternative (ELT) would be slightly higher than that described for the No Action Alternative (LLT) in Section 8.3.3.1 (Appendix 8H, *Electrical Conductivity*, Table EC-27). The frequency of exceedance of the Bay-Delta WQCP 1,000 µmhos/cm objective would increase from 1% to 3% at Banks Pumping Plant and from 0% to 1% at Jones Pumping Plant. However, similar to the No Action Alternative (LLT), average EC levels for the entire period modeled would decrease slightly at the Banks and Jones Pumping Plants relative to Existing Conditions in the ELT time period (Appendix 8H, *Electrical Conductivity*, Table EC-28). For the reasons described for the No Action Alternative in Chapter 8, *Water Quality*, Section 8.3.3.1, the slight increase in frequency of exceedance of the EC objective under the No Action Alternative (ELT) would not be expected to adversely affect agricultural beneficial uses of this water. Further, the No Action Alternative (ELT) would not cause long-term degradation of EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions or contribute to additional CWA Section 303(d) impairment related to elevated EC in the SWP CVP Export Service Areas waters, because long-term average EC levels would be lower in the exported water. The lower average EC in the exported water would be expected to result in an improvement in lower San Joaquin River EC levels, as these levels are related, in part, by the irrigation deliveries from the Delta.

In summary, the increased frequency of exceedance of EC objectives and increased drought period average EC levels that would occur in the western Delta under the No Action Alternative (ELT) would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act Section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in drought period average EC in the western Delta under the No Action Alternative has the potential to contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality.

CEQA Conclusion: River flow rate and reservoir storage reductions that would occur under the No Action Alternative (ELT), relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's current regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, the No Action Alternative (ELT) would not result in any substantial increases in long-term average EC levels in the SWP CVP Export Service Areas. At the Jones and Banks Pumping Plants there would be only a, respective, 1–2% increase in exceedance of the EC objective when the entire period modeled is considered. Average EC levels for the entire period modeled would decrease at both plants. Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, the minimal increase in the frequency of exceedance of the EC objective at the pumping plants for the entire period modeled coupled with the long-term average decrease in EC levels at the pumping plants would not adversely affect this beneficial use.

In the Plan Area, the No Action Alternative (ELT) would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton. Further, long-term average EC levels would increase by 1% for the entire period modeled and 10% during the drought period modeled at Emmaton. The increases in drought period average EC levels that would occur in the Sacramento River at Emmaton would further degrade existing EC levels and thus contribute additionally to adverse effects on the agricultural beneficial use. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is CWA Section 303(d) listed for elevated EC and the increases in long-term average EC and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton could make beneficial use impairment measurably worse. This impact is considered significant.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on mercury levels in surface waters upstream of the Delta relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because factors that affect mercury concentrations in surface waters upstream of the Delta are similar in the ELT and LLT under the No Action Alternative.

For the reasons stated for the No Action Alternative (LLT) in Section 8.3.3.1, any modified reservoir operations and subsequent changes in river flows at the ELT, relative to Existing Conditions, are expected to have negligible, if any, effects on average reservoir and river mercury concentrations in the Sacramento River watershed upstream of the Delta. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions due to changes in flows under the No Action Alternative (ELT).

Delta

Similar to the No Action Alternative (LLT), the No Action Alternative (ELT) would have very little effect on mercury or methylmercury concentrations in the Delta (Appendix 8I, *Mercury*, Tables I-17 and I-18), to the extent that these changes would likely not be measurable. Because of this, use of assimilative capacity for mercury would be negligible. Any small changes would not be expected to result in adverse effects to beneficial uses.

Similarly, estimates of fish tissue mercury concentrations and exceedance quotients show almost no differences would occur among sites for the No Action Alternative (ELT) as compared to Existing Conditions for the Delta sites (Appendix 8I, *Mercury*, Tables I-19a and I-19b). Peak exceedance quotients for drought conditions are all at the San Joaquin River at Buckley Cove (4.3 for Existing Conditions; 4.6 for the No Action Alternative (ELT); Eq2 model, Appendix 8I, *Mercury*, Table I-19b). These small differences of less than 7% are not expected to further degrade water quality, with regards to mercury, by measurable levels, and thus beneficial use impairment would not be made discernibly worse. Similar to waterborne concentrations of methylmercury (Appendix 8I, *Mercury*, Table I-18), the fish tissue concentrations and exceedance quotients would be highest at the San Joaquin River, Buckley Cove site during drought years. All modeled fish tissue mercury concentrations exceed tissue guidelines, with exceedance quotients greater than 1 (Appendix 8I, *Mercury*, Tables I-19a and I-19b).

Because the increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I, *Mercury*, for a complete discussion of the uncertainty associated with the fish tissue estimates. Briefly, the bioaccumulation models contain multiple sources of uncertainty associated with their development. These are related to: analytical variability; temporal and/or seasonal variability in Delta source water concentrations of methylmercury; interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and limited sample size (both in number of fish and time span over which the measurements were made), among others. Although there is considerable uncertainty in the models used, the results serve as a reasonable approximations of a very complex process. Considering the uncertainty, small (i.e., <20–25%) increases or decreases in modeled fish tissue mercury concentrations at a low number of Delta locations (i.e., 2–3) should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual adverse effects. Larger increases, or increases evident throughout the Delta, can be interpreted as more reliable indicators of potential adverse effects.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones Pumping Plants. Concentrations changes at these locations are expected to be very small, and likely not measurable. Thus, any change in use of assimilative capacity is also expected to be small and not measurable. Any increases in mercury concentrations that may occur in water exported via Banks and Jones Pumping Plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to mercury.

Relative to Existing Conditions, the No Action Alternative (ELT) would result in small changes (less than 3%) in estimated methylmercury concentrations in largemouth bass. All modeled methylmercury concentrations in largemouth bass exceed fish tissue guidelines (Appendix 8I, *Mercury*, Tables I-19a and I-19b).

***CEQA Conclusion*:** Under the No Action Alternative (ELT), greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta for Existing Conditions and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record under the No Action Alternative (ELT) would be very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for the No Action Alternative (ELT) as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones Pumping Plants. The Banks and Jones Pumping Plants are expected to show very small water concentration changes and very small changes in fish tissue concentration of mercury for the No Action Alternative (ELT) as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, the No Action Alternative (ELT) would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, this impact is considered less than significant.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on nitrate levels in surface waters upstream of the Delta relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because factors which affect nitrate concentrations in surface waters upstream of the Delta are similar in the ELT and LLT under the No Action Alternative. For the reasons stated for the No Action Alternative (LLT) in Section 8.3.3.1, any modified reservoir operations and subsequent changes in river flows at the ELT, relative to Existing Conditions, are expected to have negligible, if any, effects on average reservoir and river nitrate concentrations in the Sacramento River watershed upstream of the Delta. In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate-based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49; Figure 2 in Appendix 8J, *Nitrate*). Under the No Action Alternative (ELT), average flows at Vernalis would decrease an estimated 1% relative to Existing Conditions, which is less than the 6% decrease in average flows estimated to occur at the LLT. Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative (ELT).

Delta

Results of the mass balance calculations indicate that under the No Action Alternative (ELT), relative to Existing Conditions, nitrate concentrations throughout the Delta would remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 34). Although changes at specific Delta locations and for specific months may be substantial on a relative basis (Appendix 8J, *Nitrate*, Table 35), the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other relevant nitrate thresholds. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 Delta assessment locations except the San Joaquin River at Buckley Cove, where early long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, early long-term average nitrate concentration would be somewhat reduced under the No Action Alternative (ELT), relative to Existing Conditions. No additional exceedances of the MCL are anticipated at any location (Appendix 8J, *Nitrate*, Table 34). On a monthly average basis and a long-term annual average basis, for all modeled years (1976–1991) and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, would be low or negligible (i.e., <1%) for all locations and months (Appendix 8J, *Nitrate*, Table 36). Nitrate concentrations, change in nitrate concentrations relative to existing conditions, and use of assimilative capacity with regard to nitrate at various locations throughout the Delta under the No Action Alternative (ELT) would be approximately the same as would occur in the LLT.

As described in for the No Action Alternative for the LLT in Section 8.3.3.1, actual nitrate on concentrations would likely be higher than the modeling results indicate at certain locations under the No Action Alternative (ELT). This is because the mass balance modeling does not account for contributions from the SRWTP, which would be implementing nitrification/partial denitrification, or Delta wastewater treatment plant dischargers that practice nitrification, but not denitrification. However, for the reasons described for the No Action Alternative (LLT), additional nitrate contributions and resulting concentrations that may occur at certain locations within the Delta at the ELT would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of the No Action Alternative (ELT) on nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate at the Banks and Jones Pumping Plants.

Results of the mass balance calculations indicate that under the No Action Alternative (ELT), relative to Existing Conditions, early long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly (Appendix 8J, *Nitrate*, Table 35), as is also expected for the LLT (see Section 8.3.3.1). No exceedances of the 10 mg/L MCL would occur (Appendix 8J, *Nitrate*, Table 34). On a monthly average basis and on a long-term annual average basis, for all modeled years and for the drought period only, use of assimilative capacity available under Existing Conditions relative to the MCL would be negligible (i.e., <1%) for both Banks and Jones Pumping Plants (Appendix 8J, *Nitrate*, Table 36). As discussed above, in the Delta region, nitrate concentrations would be higher than indicated in the modeling results for areas receiving Sacramento River water, including Banks and Jones pumping plants. However, long-term average nitrate concentrations would be expected to decrease under the No Action Alternative (ELT), relative to Existing Conditions. Resultant nitrate concentrations in water exported via Banks and Jones pumping plants under the No Action Alternative (ELT) are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regard to nitrate.

In summary, based on the discussion above, effects on nitrate of facilities operation and maintenance are considered not adverse.

CEQA Conclusion: For the same reasons described for the LLT in Section 8.3.3.1, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative (ELT), relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mass balance calculations indicate that under the No Action Alternative (ELT), relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, would be low or negligible (i.e., <1%) for all locations and months.

Results of the mass balance calculations indicate that under the No Action Alternative (ELT), relative to Existing Conditions, average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL would be negligible (i.e., <1%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the SWP/CVP Export Service Areas under the No Action Alternative (ELT), relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment from nitrate. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered less than significant.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

While increased water demands and climate change under the No Action Alternative (ELT) would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta. Consequently, long-term average DOC concentrations under the No Action Alternative (ELT) would not be expected to change by frequency, magnitude and geographic extent, relative to Existing Conditions and, and thus, would not adversely affect the MUN beneficial use, or any other beneficial uses, in water bodies of the affected environment located upstream of the Delta.

Delta

Relative to the Existing Conditions, the No Action Alternative (ELT) would result in no changes, or a 0.1 mg/L decrease, in the long-term average DOC concentrations at the 11 assessment locations for the modeled 16-year period. However, the average DOC concentrations would increase slightly (i.e., up to 0.1 mg/L) in the modeled drought period (1987–1991) only at the Jones pumping plant location (Appendix 8K, *Organic Carbon*, Table DOC-11). At all 11 assessment locations, the range of frequency with which average DOC concentrations would exceed the 2 mg/L threshold concentration under the No Action Alternative (ELT) would be similar to Existing Conditions (i.e., 93–100%) for the modeled 16-year period and the drought period. The frequency with which DOC concentration would exceed the 3 mg/L and 4 mg/L thresholds also would be similar at most of the assessment locations, with exception of predicted changes at both the Banks and Jones pumping plants (discussed further below). While the No Action Alternative (ELT) would generally lead to similar or slightly higher long-term average DOC concentration in the western and interior Delta locations, the predicted changes would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration (i.e., ≤0.1 mg/L).

SWP/CVP Export Service Areas

With respect to the potential for effects of the No Action Alternative (ELT), the long-term average DOC concentrations in water exported at the Banks and Jones pumping plants would not change measurably relative to Existing Conditions (i.e., up to 0.1 mg/L at Jones pumping plant for the modeled drought period) (Appendix 8K, *Organic Carbon*, Table DOC-11). At the Banks pumping plant, the frequency with which DOC concentrations would exceed 3 mg/L would increase from 64% under Existing Conditions to 69% under the No Action Alternative (ELT) for the 16-year period, and from 57% to 70% during the drought year period (Appendix 8K, *Organic Carbon*, Table DOC-11). The frequencies of exceedance of 3 mg/L at the Jones pumping plant would increase from 71% to 79% for the modeled 16-year and from 72% to 88% for the modeled drought period. The relative increase in the frequency with which DOC concentrations would exceed 4 mg/L at both the Banks and Jones pumping plants would be minimal (i.e., up to a 3% increased frequency at the Jones pumping plant). However, the predicted changes in long-term average DOC concentrations would not be expected to be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial use, within the SWP/CVP Export Service Areas. Long-term average DOC concentrations, and frequency of exceedance of threshold concentrations, would decrease slightly at Barker Slough under the No Action Alternative (ELT) relative to Existing Conditions.

In summary, the potential operations- and maintenance-related changes to DOC concentrations under the No Action Alternative (ELT) at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service Areas would generally be similar to, or of lower magnitude, than the effects described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because the effects of climate change on hydrology and sea level rise would be less in the ELT compared to the LLT, and thus factors affecting DOC concentrations, would be lower in these water bodies in the ELT.

Maintenance of SWP and CVP facilities under the No Action Alternative (ELT) would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected environment.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on DOC concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar, or of lower magnitude, than the effects described for the No Action Alternative (LLT). While greater water demands and climate change under the No Action Alternative (ELT) would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Based on the above, the No Action Alternative (ELT) would not result in any substantial increase in the frequency with which long-term average DOC concentrations exceed the 2, 3, or 4 mg/L levels at any of the 11 assessment locations relative to Existing Conditions. The predicted change in long-term average DOC concentrations, relative to Existing Conditions, would not be expected to be of sufficient magnitude to adversely affect MUN beneficial uses, nor would there be any long-term water quality degradation with respect to DOC. DOC is not bioaccumulative and thus would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations would not be expected to increase substantially, no significant impacts on beneficial uses would occur. Based on these findings, this impact would be less than significant.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because the factors that would affect pathogen levels in the surface waters of these areas would be similar in the ELT and LLT. The difference in reservoir storage, river flows, and associated changes in Delta source water fractions due to climate change and sea level rise would not alter the pathogen sources in these waters. Thus, for the reasons described for the No Action Alternative in Section 8.3.3.1, the effects on pathogens from implementing the No Action Alternative (ELT) is determined to not be adverse.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative. This is because the factors that would affect pathogen levels in the surface waters of these areas would be similar in the ELT and LLT. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered less than significant.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on pesticide levels in surface waters upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or less than those expected to occur at the LLT, described in Section 8.3.3.1. This is because at the ELT, the primary factor that will influence pesticide concentrations in surface waters upstream of the Delta, the effect of timing and magnitude of reservoir releases on dilution capacity, is expected to change to a similar or less degree than under the No Action Alternative (LLT). Changes in average winter and summer flow rates at the ELT relative to Existing Conditions are expected to be similar to or less than changes in flow rates expected at the LLT in the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis (Appendix 8L, *Pesticides,* Tables 1 through 4). Similarly, at the ELT, the primary factor that will influence pesticide concentrations in surface waters of the Delta and in the SWP/CVP Export Service areas (i.e., changes in San Joaquin River, Sacramento River and Delta agriculture source water fractions at various Delta locations, including Banks and Jones pumping plants) is expected to change by a similar or less degree than at the LLT. The percentage change in monthly average source water fractions at the ELT are similar to or less than changes expected at the LLT (Appendix 8D, *Source Water Fingerprinting Results*).

Development of 8,000 acres of tidal habitat under the No Action Alternative (ELT) could result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with these measures may expose water used for habitat restoration to pesticide residues. Moreover, the fisheries enhancements to the Yolo Bypass that would occur under the No Action Alternative (ELT) could be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected.

***CEQA Conclusion*:** As discussed above, the effects of the No Action Alternative (ELT) on pesticide levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative in Section 8.3.3.1. As such, the No Action Alternative (ELT) would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP CVP Export Service Areas. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous CWA Section 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered less than significant.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on phosphorus levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or less than those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is because factors which affect phosphorus levels in surface waters of these areas would be similar at the ELT and LLT under the No Action Alternative. Phosphorus concentrations may increase during January through March at locations in the Delta where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. However, based on the DSM2 fingerprinting results (see Figures 288–308 in Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations (presented in Figure 8-56), the magnitude of increases during these months is expected to be negligible (i.e., <0.01 mg/L) at all Delta locations. Thus, phosphorus levels in the Delta and waters exported from Banks and Jones pumping plants to the SWP/CVP Export Service Areas are expected to change less at the ELT compared to the LLT. For the reasons described for the No Action Alternative in Section 8.3.3.1 and those described above, the effects on phosphorus from implementing the No Action Alternative (ELT) is determined to not be adverse.

***CEQA Conclusion*:** The effects of the No Action Alternative (ELT) on phosphorus levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative in Section 8.3.3.1. This is because factors that would directly affect phosphorus levels in the surface waters of these areas are expected to be the same or change to a lesser degree than at the LLT. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on selenium concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for the No Action Alternative (LLT) in Section 8.3.3.1. There would be no expected change to the sources of selenium in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on the concentration of selenium in the rivers and reservoirs of these watersheds.

Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative (ELT). This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010a) and State Water Board (2010d, 2010e) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, Further, modeling of flows for the San Joaquin River at Vernalis indicates that average annual flows under the No Action Alternative (ELT) will vary by less than 10% from Existing Conditions (Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative (ELT).

In summary, any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Relative to Existing Conditions, the No Action Alternative (ELT) would result in little to no change in average selenium concentrations in water at all modeled Delta assessment locations. Long-term average concentrations would be the same or lower, with the exception of Old River at Rock Slough during the drought (1987–1991) period modeled, the Sacramento River at Emmaton and North Bay Aqueduct Pumping Plant for the entire and drought periods modeled, and Contra Costa Pumping Plant No. 1 for the entire (1976–1991) period modeled (Appendix 8M, *Selenium*, Table M-33). Long-term average concentrations at these locations would increase negligibly (by 0.01μg/L). The long-term average selenium concentrations in water under the No Action Alternative (ELT) would range from 0.09–0.39 μg/L (Appendix 8M, *Selenium*, Table M-33), which would be well below the EPA draft water quality criterion of 1.3 μg/L. Thus, the No Action Alternative (ELT) would not result in selenium concentration increases in water that would substantially degrade water quality.

Relative to Existing Conditions, the No Action Alternative (ELT) would result in little to no change in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), with the largest increase being 0.01 mg/kg dry weight (Appendix 8M, *Selenium*, Table M-34). During the drought period, concentrations of selenium in sturgeon in the western Delta would increase slightly, with about a 0.19 mg/kg dry weight (<3%) increase for the San Joaquin River at Antioch (Appendix 8M, *Selenium*, Tables M-41 and M-42).

All Toxicity Threshold Exceedance Quotients for whole fish, bird eggs, and fish fillets are less than 1.0, indicating low probability of adverse effects (Appendix 8M, *Selenium*, Table M-37). Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon from the western Delta exceed 1.0 for the drought period, indicating a higher probability for adverse effects for drought years (Appendix 8M, *Selenium*, Table M-43). Relative to Existing Conditions, Exceedance Quotients would increase by 0.00–0.02, indicating that there would be essentially no increased risk of toxicity associated with selenium concentrations under the No Action Alternative (ELT).

In summary, relative to Existing Conditions, the No Action Alternative (ELT) would result in essentially no change in selenium concentrations throughout the Delta. The No Action Alternative (ELT) would not be expected to substantially increase the frequency with which the applicable water quality criterion or toxicity or level of concern thresholds would be exceeded in the Delta or to substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Relative to Existing Conditions, the No Action Alternative (ELT) would result in little to no change in average selenium concentrations in water at the south Delta pumping plants. At the Banks pumping plant, there would be no change in long-term average concentrations for the entire period modeled or the drought period modeled (Appendix 8M, *Selenium*, Table M-33). At the Jones pumping plant, selenium concentrations would increase by 0.01 μg/L for the entire period modeled (Appendix 8M, *Selenium*, Table M-33). Furthermore, the modeled selenium concentrations in water for the No Action Alternative (ELT) would range from 0.21–0.29 μg/L, well below the USEPA water quality criterion of 1.3 μg/L (Appendix 8M, *Selenium*, Table M-33).

Similarly, the No Action Alternative (ELT) would result in little to no change in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), and concentrations of selenium in biota would not be expected to exceed any toxicity or level of concern benchmarks for biota (Appendix 8M, *Selenium*, Tables M-34 and Se-37).

Residence time of water in the Delta is not expected to change substantially under the No Action Alternative (ELT) relative to Existing Conditions. Thus, any minor residence time changes would not be expected to affect selenium bioaccumulation or fish tissue and bird egg concentrations of selenium.

In summary, relative to Existing Conditions, the No Action Alternative (ELT) would result in essentially no change in selenium concentrations in the SWP/CVP Export Service Areas, because there would essentially be no change in selenium concentrations at the Bank and Jones pumping plants. Thus, the No Action Alternative (ELT) would not be expected to substantially increase the frequency with which applicable water quality criteria, or toxicity and level of concern benchmarks would be exceeded in the Export Service Areas or substantially degrade the quality of water in the Export Service Areas, with regard to selenium.

CEQA Conclusion: There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative (ELT), relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that the No Action Alternative (ELT) would result in essentially no change in selenium concentrations throughout the Delta, with all changes on the order of 0.01 μg/L or less. Furthermore, there would not be an increased risk of exceeding toxicity and level of concern benchmarks for biota.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, the No Action Alternative (ELT) would result in no change in long-term average selenium concentrations at the Bank pumping plant, and very little increase (0.01 μg/L) at the Jones pumping plant.

Based on the above, selenium concentrations that would occur in water under this alternative would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered less than significant.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on trace metal concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative in Section 8.3.3.1. This is because the factors that would affect trace metal concentrations in the surface waters of these areas would be the same in the ELT as in the LLT. For the reasons described for the No Action Alternative in Section 8.3.3.1, the effects on trace metal concentrations from implementing the No Action Alternative (ELT) is determined to not be adverse.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on trace metal concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative. This is because the factors that would affect trace metal concentrations in the surface waters of these areas would be similar in the ELT and LLT. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, negligible change in long-term trace metal concentrations throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered less than significant.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on TSS and turbidity levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative in Section 8.3.3.1. This is because the factors that would affect TSS and turbidity levels in the surface waters of these areas would be the same in the ELT as in the LLT. For the reasons described for the No Action Alternative (LLT) in Section 8.3.3.1, the effects on TSS and turbidity from implementing the No Action Alternative (ELT) is determined to not be adverse.

CEQA Conclusion: The effects of the No Action Alternative (ELT) on TSS and turbidity levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the No Action Alternative. This is because the factors that would affect TSS and turbidity levels in the surface waters of these areas would be similar in the ELT and LLT. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different from Existing Conditions, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered less than significant.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities

The effects of construction-related activities and potential water quality effects that would occur under the No Action Alternative (ELT) in association with projects other than Alternative 4A would be similar to those described for the No Action Alternative in Section 8.3.3.1. This is because many construction-related activities that could affect the surface waters in the project area are ongoing (e.g., urban development), or recurring (e.g., maintenance activities for channels and levees, sediment dredging), and thus are expected to result in generally similar effects in the ELT and LLT. While the timing of construction of planned projects, described under the No Action Alternative (ELT) (e.g., restoration projects), is uncertain relative to the Existing Conditions, the potential construction-related contaminant discharges that may occur under the No Action Alternative (ELT) would be avoided and minimized upon implementation of BMPs and adherence to permit terms and conditions. Consequently, construction-related activities would not be expected to cause constituent discharges of sufficient magnitude to result in a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas.

CEQA Conclusion: Alternative 4A construction-related contaminant discharges under the No Action Alternative (ELT) would not occur. Other reasonably foreseeable projects that are independent from Alternative 4A would result in construction-related impacts that are temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or CWA Section 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would therefore not contribute to bioaccumulation of contaminants in organisms or humans or cause Section 303(d) impairments to be discernibly worse. Relative to Existing Conditions, the construction-related effects of other projects in the Delta would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality on a long-term average basis with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas. Based on these findings, this impact is determined to be less than significant.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the No Action Alternative (ELT) on *Microcystis* levels, and thus microcystin concentrations, in surface waters upstream of the Delta relative to Existing Conditions would be similar to those described for the No Action Alternative in Section 8.3.3.1. This is because factors that would affect *Microcystis* levels in these areas would be the same in the ELT and the LLT. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under the No Action Alternative (ELT).

Delta

In the Delta, enhancements to the Yolo Bypass and 8,000 acres of tidal habitat would be developed under the No Action Alternative (ELT). The hydrodynamic effects of these actions could lead to increased residence times in the affected Delta sub-regions relative to Existing Conditions. As described in Section 8.3.3.1, climate change and sea level rise are also expected to cause slight increases in water residence times throughout the Delta at the LLT. At the ELT the incremental contribution of climate change and sea level rise to increased water residence times would be less than that at the LLT.

Due to the assumed effects of climate change, Delta water temperatures are expected to increase relative to Existing Conditions under the No Action Alternative (ELT), although the magnitude of increase would be less at the ELT (1.3–2.5°F) compared to the LLT (2.9–4.9°F). Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under the No Action Alternative (ELT), relative to Existing Conditions. However, the effects of elevated ambient water temperatures on *Microcystis* at the ELT are expected to be less than would occur at the LLT.

The combination of increased water residence times in the Delta, due to assumed restoration activities, and increased water temperatures, due to climate change, could lead to measurable increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta at the ELT, relative to Existing Conditions. It is not expected that the effects on *Microcystis* in the Delta that could occur at the ELT would be significantly different than those that could occur at LLT.

SWP/CVP Export Service Area

The effects of the No Action Alternative (ELT) on *Microcystis* levels, and thus microcystin concentrations, in SWP/CVP Export Service Areas, relative to Existing Conditions, would be similar to or slightly less than those described for the No Action Alternative (LLT) in Section 8.3.3.1. This is for two reasons. First, the assessment of effects on *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones pumping plants, and the effects on *Microcystis* at Banks and Jones pumping plants is not expected to be different at the ELT and LLT for the reason discussed for the "Delta" above. Second, changes in ambient air temperatures due to climate change are expected to be less at the ELT compared to the LLT, as described for the "Delta" above. Thus, effects of climate change on the potential for environmental conditions in the SWP/CVP Export Service Areas to become more conducive for *Microcystis* growth, relative to Existing Conditions, are expected to be less at the ELT than at the LLT.

CEQA Conclusion: For the reasons described above, the effects of the No Action Alternative (ELT) on *Microcystis* levels, and thus microcystin concentrations, in surface waters upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or less than those described for the No Action Alternative (LLT) in Section 8.3.3.1. As such, the No Action Alternative (ELT) would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that under the No Action Alternative (ELT) increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta would occur due to both increased water temperatures from climate change, as well as increased water residence times related to restoration activities, long-term water quality degradation may occur in the Delta and water exported from the Delta to the SWP/CVP Export Service Areas. Thus, impacts on beneficial uses could occur. This impact is considered significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance

The effects of the No Action Alternative (ELT) on San Francisco Bay water quality would be similar to those described for the No Action Alternative (LLT) (see Section 8.3.3.1 and Appendix 8O, *San Francisco Bay Analysis*). The primary difference in the ELT is that the effects of climate change on upstream hydrology and sea level rise in the Delta and Bay would be less. However, for the same reasons described for the LLT, upstream constituent concentrations and Delta outflow would not be altered sufficiently by these differences to cause substantial water degradation or contribute to adverse effects to beneficial uses in San Francisco Bay.

CEQA Conclusion: The No Action Alternative (ELT) would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes in these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow and thus, have minimal influence on salinity changes. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus have not been detected downstream of Suisun Bay. The reduction in total nitrogen load (associated with the SRWTP improvements) and changes in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. As with the LLT, the change in mercury and methylmercury load (which is based on source water and Delta outflow), relative to Existing Conditions, would be within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Similarly, based on LLT estimates, the increase in selenium load would be minimal, and total and dissolved selenium concentrations would be expected to be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the change in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant.

8.3.4.2 Alternative 4A—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Discussion of water quality impacts of Alternative 4A was first provided in the Bay Delta Conservation Plan/California WaterFix RDEIR/SDEIS. The water quality assessments in the RDEIR/SDEIS for boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Services Areas utilized results from water quality modeling performed for Alternative 4 in the ELT, which included Yolo Bypass improvements, 25,000 acres of tidal habitat restoration, and the EC compliance location at Emmaton relocated to Threemile Slough. The analysis of effects of Alternative 4A, presented herein, on boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Service Areas is based on revised modeling, which assumed implementation of Yolo Bypass improvements, the EC compliance location remaining at Emmaton, and no tidal habitat restoration. Also, whereas the RDEIR/SDEIS Alternative 4A included two operational scenarios (H3 and H4), modeling for Alternative 4A was conducted at Operational Scenario H3+, a point that generally falls between Scenario H3 and H4 operations, as the initial conveyance facilities operational scenario. As specified in Chapter 3, *Description of Alternatives*, Section 3.6.4, the Delta outflow criteria under Scenario H for Alternative 4A would be determined by the Endangered Species Act and California Endangered Species Act Section 2081 permits, and operations to obtain such outflow would likely occur between Scenarios H3 and H4. Modeling results for Scenarios H3 and H4 using the 2015 CALSIM II model are shown in Appendix 5E, *Supplemental Modeling Requested by the State Water Resources Control Board Related to Increased Delta Outflows*, Attachment 1. In addition, following the initial operations, the adaptive management and monitoring program could be used to make long-term changes in initial operations criteria to address uncertainties about spring outflow for longfin smelt and fall outflow for delta smelt, among other species.

Future conveyance facilities operational changes may also be made as a result of adaptive management to respond to advances in science and understanding of how operations affect species. Conveyance facilities would be operated under an adaptive management range represented by Boundary 1 and Boundary 2 (See Section 5E.2 of Appendix 5E for additional information on Boundary 1 and Boundary 2). Impacts as a result of operations within this range would be consistent with the impacts discussed for the range of alternatives considered in this EIR/EIS. As shown in Appendix 5F, water supply modeling results for H3+ are within the range of results for Scenarios H3 and H4, and are consistent with the impacts discussed in the RDEIR/SDEIS. The following analysis of Alternative 4A impacts reflects modeling results of Operational Scenario H3+.

Because the modeling of Alternative 4A and the No Action Alternative (ELT) included Yolo Bypass Improvements, but no tidal habitat restoration, comparison of modeling results for Alternative 4A to No Action Alternative (ELT) results in the impact discussions below allows for isolating and identifying effects solely due to implementation of Alternative 4A in the ELT.

As described in Chapter 3, *Description of Alternatives*, actions associated with Alternative 4 that are not proposed to be implemented under Alternative 4A would continue to be pursued as part of existing, but separate, projects and programs associated with the 2008 USFWS and 2009 NMFS BiOps, California EcoRestore, and the 2014 California Water Action Plan. Due to the reduced suite of Environmental Commitments in Alternative 4A compared to Alternative 4 (in particular, significantly less tidal habitat restoration), the impacts to water quality due to Alternative 4A are substantially less compared to Alternative 4, particularly in the Delta.

The water quality impact conclusions for Alternative 4A remain the same as those presented in the RDEIR/SDEIS. The revisions to the assessment are in the presentation of modeled changes in concentrations, water quality criteria/objective exceedances, and use of assimilative capacity, and refinements to mitigation measures for EC.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), substantial point and non-point sources of ammonia-N do not exist upstream of the SRWTP at Freeport in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Thus, like Alternative 4, operation of the water conveyance facilities under Alternative 4A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT and LLT). Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As described for Alternative 4 (Section 8.3.3.9), a substantial decrease in Sacramento River ammonia concentrations is expected under Alternative 4A relative to Existing Conditions, due to planned lowering of ammonia in the SRWTP effluent discharge, and this is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water.

Concentrations of ammonia at locations not influenced notably by Sacramento River water would change little relative to Existing Conditions, due to the similarity in San Joaquin River and San Francisco Bay concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 4A would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Relative to the No Action Alternative (ELT and LLT), the primary mechanism that could potentially alter ammonia concentrations under Alternative 4A is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This flow change would be attributable only to operations of the water conveyance facilities, since the same assumptions regarding SRWTP discharge ammonia concentrations, water demands, climate change, and sea level rise apply to both Alternative 4A and the No Action Alternative (ELT and LLT). A simple mass balance calculation was performed to calculate ammonia concentrations downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 4A and the No Action Alternative (ELT) to assess the effects of the flow changes. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia limitations (1.5 mg/L-N in Apr–Oct, 2.4 mg/L-N in Nov–Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-73 shows monthly average and long-term annual average predicted concentrations under the alternative. As Table 8-73 shows, average monthly ammonia concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 4A and the No Action Alternative (ELT) are expected to be similar. In comparison to the No Action Alternative (ELT), minor increases in monthly average ammonia concentrations would occur during July through September, and during November. Minor decreases in ammonia concentrations are expected for January through April, June, and October. The annual average concentration under Alternative 4A would be the same as that under the No Action Alternative (ELT). Relative to the No Action Alternative (LLT), Alternative 4A (LLT) is expected to result in similar minor increases in Sacramento River ammonia concentration, because the increased water demands, climate change, and sea level rise in the LLT would occur under both alternatives, and neither would affect ammonia sources or loading. The estimated ammonia concentrations in the Sacramento River downstream of Freeport under Alternative 4A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 4A, relative to the No Action Alternative (ELT and LLT), are not expected to substantially increase ammonia concentrations at any Delta locations.

Ammonia concentrations downstream of Freeport in the Sacramento River under Alternative 4A would be similar to those under Alternative 4 (see Table 8-67 in Section 8.3.3.9). As stated for Alternative 4, any negligible increases in ammonia concentrations that could occur at certain locations in the Delta under Alternative 4A would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to ammonia.

Table 8-73. Estimated Ammonia (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative Early Long-Term (ELT) and Alternative 4A

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative (ELT)	0.076	0.082	0.069	0.062	0.059	0.062	0.059	0.062	0.067	0.060	0.067	0.064	0.066
Alternative 4A ELT	0.075	0.086	0.069	0.061	0.058	0.061	0.058	0.062	0.063	0.061	0.069	0.066	0.066

SWP/CVP Export Service Areas

As discussed above, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4A, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). Like Alternative 4, this decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regard to ammonia. Furthermore, as discussed above, for all areas of the Delta, including Banks and Jones pumping plants, ammonia concentrations are not expected to be substantially different under Alternative 4A (ELT) relative to the No Action Alternative (ELT), and Alternative 4A (LLT) relative to the No Action Alternative (LLT). Thus, any negligible increases in ammonia concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade water quality at these locations, with regard to ammonia.

NEPA Effects: In summary, ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas are not expected to be substantially different under Alternative 4A relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on ammonia are considered to be not adverse.

CEQA Conclusion: The magnitude and direction of changes in ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas would be approximately the same as expected under Alternative 4, relative to Existing Conditions. There would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 4A relative to Existing Conditions. As such, Alternative 4A is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Some habitat restoration activities included in Environmental Commitments 3, 4, and 6–11 would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect ammonia sources or loading. Based on these findings, the effects on ammonia from the implementation Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A are determined to not be adverse.

***CEQA Conclusion*:** Land use changes that would result from the Environmental Commitments are not expected to substantially increase ammonia concentrations, because the amount of area to be converted would be small relative to existing habitat, and any resulting ammonia would likely be rapidly converted to nitrate. Thus, it is expected there would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. As such, implementation of these Environmental Commitments would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these Environmental Commitments, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 4A there would be no expected change to the sources of boron in the Sacramento River and eastside tributary watersheds and, thus, resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease by 1%, relative to Existing Conditions (in association with the different operational components of Alternative 4A in the ELT, climate change, and increased water demands) (Appendix 8F, *Boron*, Table Bo-32). The reduced flow relative to Existing Conditions would result in possible increases in long-term average boron concentrations of up to about 0.5% relative to the Existing Conditions. Flows would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial boron increases relative to the No Action Alternative (ELT). The increased boron concentrations, relative to Existing Conditions, under Alternative 4A in the ELT would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 4A in the ELT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 4A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect boron sources in these areas.

Delta

Effects of water conveyance facilities on boron under Alternative 4A in the Delta would be similar to the effects discussed for Alternative 4.

The effects of Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action Alternative (ELT), Alternative 4A would result in increased long-term average boron concentrations for the 16-year period modeled at most of the interior Delta locations (increases up to 2% at the S. Fork Mokelumne River at Staten Island, 8% at Franks Tract, and 10% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-26). The long-term average boron concentrations at most of the western Delta assessment locations would not change measurably. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or the 500 μg/L agricultural objective at the majority of assessment locations, which represents no change from the Existing Conditions and No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-3C). A small increase in the frequency of exceedances 500 μg/L agricultural objective at the Sacramento River at Mallard Island (i.e., as much as 3% in the drought period relative to the No Action Alternative [ELT]) would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. Minor reductions in long-term average assimilative capacity of up to 6% at interior Delta locations (i.e., Old River at Rock Slough) would occur with respect to the 500 μg/L agricultural objective (Appendix 8F, *Boron*, Table Bo-27). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 4A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, *Boron*, Figure Bo-6).

Effects of Alternative 4A in the Delta in the LLT, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to those described above for the ELT. Boron concentrations may be higher at western Delta locations due to greater effects of climate change on sea level rise that would occur in the LLT; however, these effects are independent of the alternative.

Further, boron is of concern in waters diverted for agricultural use, which primarily occurs in the interior Delta, and based on Delta source water characteristics (see Table 8-42 in Section 8.3.1.7, *Construction-Specific Considerations Used in the Assessment*), boron concentrations in the interior Delta would be expected to remain suitable for agricultural use.

SWP/CVP Export Service Areas

Under Alternative 4A, long-term average boron concentrations would decrease at the Banks pumping plant (20%) and at Jones pumping plant (23%) relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-26) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing CWA Section 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading. These same effects on boron at the Banks and Jones pumping plants would be expected in the LLT, because the primary effect of climate change on sea level rise and boron concentrations is expected in the western Delta.

Maintenance of SWP and CVP facilities under Alternative 4A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative (ELT and LLT), Alternative 4A would result in relatively small increases in long-term average boron concentrations in the Delta, not measurably increase boron levels in the lower San Joaquin River, and reduce boron levels in water exported to the SWP/CVP export service areas. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Based on the above assessment, any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels upstream of the Delta. Small increases in boron levels predicted for interior Delta locations in response to a shift in the Delta source water percentages would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 4A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 4A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 4A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing CWA Section 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 4A would present no new direct sources of boron to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. Habitat restoration activities in the Delta, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative (ELT and LLT). Consequently, as they pertain to boron, implementation of the Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 4A would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. As such, their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 4A in the ELT there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Thus, changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial bromide increases (Appendix 8E, *Bromide*, Table 24). Moreover, there are no existing municipal intakes on the lower San Joaquin River, which is the beneficial use most sensitive to elevated bromide concentrations. Consequently, Alternative 4A in the ELT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the San Joaquin River, the eastside tributaries, or their associated reservoirs upstream of the Delta due to changes in bromide concentrations.

Effects of Alternative 4A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect bromide sources in these areas.

Delta

Estimates of bromide concentrations at Delta assessment locations were generated using a mass balance approach, and using relationships between EC and chloride and between chloride and bromide and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in bromide at Delta assessment locations based on both approaches.

Based on the mass balance modeling approach for bromide, relative to Existing Conditions, Alternative 4A long-term average bromide concentrations would increase in the S. Fork Mokelumne River at Staten Island, and decrease at all other assessment locations (Appendix 8E, *Bromide*, Table 22). Average bromide concentrations at Staten Island would increase from 50 µg/L under Existing Conditions to 54 µg/L (8% increase) for the modeled 16-year hydrologic period (1976–1991). However, multiple interior and western Delta assessment locations would have an increased frequency of exceedance of 50 µg/L, which is the CALFED Drinking Water Program goal for bromide as a long-term average applied to drinking water intakes (Appendix 8E, *Bromide*, Table 22). These locations are the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. The greatest increase in frequency of exceedance of the CALFED Drinking Water Program long-term goal of 50 µg/L would occur in the S. Fork Mokelumne River (7% increase) and Sacramento River at Emmaton (4% increase). The increase in frequency of exceedance of the 50 µg/L threshold at the other locations would be 2% or less. Similarly, these locations and the Contra Costa Pumping Plant #1 would have an increased frequency of exceedance of 100 µg/L, which is the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts (Appendix 8E, *Bromide*, Table 22). The greatest increase in frequency of exceedance of 100 µg/L would occur at Sacramento River at Emmaton (5% increase) and San Joaquin River at Antioch and Franks Tract (4% increase). The increase in frequency of exceedance of the 100 µg/L threshold at the other locations would be 3% or less.

Changes in long-term average bromide concentrations and changes in threshold exceedance frequencies relative to the No Action Alternative (ELT) are generally of similar magnitude to those previously described relative to Existing Conditions (Appendix 8E, *Bromide*, Table 22). However, unlike the Existing Conditions comparison, relative to the No Action Alternative (ELT), long-term average bromide concentrations in the San Joaquin River at Buckley Cove and the North Bay Aqueduct at Barker Slough would increase under Alternative 4A, although the increases would be relatively small (<1%). Further, at the North Bay Aqueduct, the frequency of exceedance of 50 µg/L would increase from 35% to 40%; there would be no increased exceedance of the 100 µg/L threshold. The increase in the frequency of exceedance of the 50 µg/L threshold at the other locations would be 3% or less, The frequency of exceedance of the 100 µg/L at the other locations would increase relative to the No Action Alternative (ELT) by 2% or less in the Mokelumne River at Staten Island, Franks Tract, in Old River at Rock Slough, in the San Joaquin River at Antioch, in the Sacramento River at Mallard Island, and at Contra Costa. There would not be an increased exceedance of the 100 µg/L threshold at Emmaton.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide were consistent with the discussion above, and assessment of bromide using these modeling results leads to the same conclusions as are presented above for the mass balance approach (Appendix 8E, *Bromide*, Table 23).

The magnitude of bromide concentration increases at Mallard Slough and in the San Joaquin River at Antioch during their historical months of use, relative to Existing Conditions and the No Action Alternative (ELT) would be generally similar to those described for Alternative 4 (Appendix 8E, *Bromide*, Table 25), and the frequency of exceedance of bromide thresholds would be similar (Appendix 8E, *Bromide*, Table 22). As described for Alternative 4, the use of seasonal intakes at these locations is largely driven by acceptable water quality, and thus has historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at Antioch and Mallard Slough would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The effects of Alternative 4A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above. There may be higher bromide concentrations in the LLT in the western Delta, but this would be associated with sea level rise, not the project alternative, because the primary source of bromide to the Delta is sea water intrusion.

SWP/CVP Export Service Areas

Under Alternative 4A, long-term average bromide concentrations at the Banks and Jones pumping plants, based on the mass balance modeling approach, would decrease. Long-term average bromide concentrations for the modeled 16-year hydrologic period at the pumping plants would decrease by as much as 46% relative to Existing Conditions and 43% relative to the No Action Alternative (ELT) (Appendix 8E, *Bromide*, Table 22). As a result, less frequent exceedances of the 50 μg/L and 100 μg/L assessment thresholds would occur and an overall improvement in SWP/CVP Export Service Areas water quality would occur respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also occur since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide are consistent with the mass balance results, and assessment of bromide using these modeling results leads to the same conclusions as are presented for the mass balance approach (Appendix 8E, *Bromide*, Table 23).

The effects of Alternative 4A in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above, because the sea level rise that could occur in the LLT would not be expected to result in substantial bromide contributions to the water exported at Banks and Jones pumping plants.

Maintenance of SWP and CVP facilities under Alternative 4A would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects**:** In summary, the operations and maintenance activities under Alternative 4A, relative to the No Action Alternative (ELT and LLT) would result in an increased frequency of exceedance of both the 50 μg/L and 100 μg/L bromide thresholds for protecting against the formation of disinfection byproducts in treated drinking water at the S. Fork Mokelumne River at Staten Island, Franks Tract,San Joaquin River at Antioch, and Sacramento River at Mallard Island. In addition, there would be an increased frequency of exceedance of the 50 μg/L threshold at Emmaton and the North Bay Aqueduct at Barker Slough, and an increased frequency of exceedance of the 100 μg/L threshold in the Old River at Rock Slough and at Contra Costa Pumping Plant #1. However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island, the San Joaquin River at Buckley Cove, and the North Bay Aqueduct at Barker Slough; there would be decreases in long-term average bromide concentrations at the other assessment locations. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island would be less than the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts, and the increase in the San Joaquin River at Buckley Cove and the North Bay Aqueduct at Barker Slough would be minimal (<2%). Thus, these increased bromide concentrations are not expected to result in adverse effects to MUN beneficial uses, or any other beneficial use, at these locations. Based on these findings, this effect is determined to not be adverse.

***CEQA Conclusion*:** While greater water demands under Alternative 4A would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the San Joaquin River, the eastside tributaries, and the various reservoirs of the related watersheds, as described for Alternative 4 (see Section 8.3.3.9).

Under Alternative 4A there would be an increased frequency of exceedance of both the 50 μg/L and 100 μg/L bromide thresholds for protecting against the formation of disinfection byproducts in treated drinking water at the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. Also, there would be an increased frequency of exceedance of the 100 μg/L threshold at the Contra Costa Pumping Plant #1. However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island and decrease at all other assessment locations. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island (54 μg/L) would be less than the 100 μg/L believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts. Further, as described for Alternative 4 (see Section 8.3.3.9), the use of seasonal intakes at Antioch and Mallard Island is largely driven by acceptable water quality, and thus has historically been opportunistic and opportunity to use these intakes would remain. Thus, these increased bromide concentrations would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Long-term average bromide concentrations at the Banks and Jones pumping plants are predicted to decrease by as much as 46% relative to Existing Conditions and there would be less frequent exceedance of bromide concentration thresholds.

Based on the above, Alternative 4A would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. Alternative 4A would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 μg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 µg/L assessment threshold concentration would be 5% or less at all locations assessed, which is considered to be less than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the Alternative 4A would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not CWA Section 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant. No mitigation is required.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Therefore, as they pertain to bromide, implementation of these Environmental Commitments would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

Environmental Commitment 4 would result in some tidal habitat restoration, however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable bromide concentration changes.

In summary, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A relative to the No Action Alternative (ELT and LLT), would have negligible, if any, effects on bromide concentrations. Therefore, the effects on bromide from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would not present new or substantially changed sources of bromide to the affected environment. Some Environmental Commitments may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 4A on chloride concentrations in reservoirs and rivers upstream of the Delta would be the similar to those effects described for Alternative 4 (see Section 8.3.3.9). Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. There would be no expected change to the sources of chloride in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial chloride increases. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, Alternative 4A in the ELT would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 4A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect chloride sources in these areas.

Delta

Estimates of chloride concentrations at Delta assessment locations were generated using a mass balance approach and EC-chloride relationships and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in chloride at Delta assessment locations based on both approaches.

Modeling of chloride using both the mass balance approach and EC-chloride relationship predicts that Alternative 4A in the ELT would result in reduced long-term average chloride concentrations, relative to Existing Conditions, for the 16-year period modeled at all assessment locations except for the S. Fork Mokelumne River at Staten Island. The increase in long-term average chloride concentration at Staten Island would be 1 mg/L (7%) based on the mass balance modeling and <1 mg/L (3%) based on the EC-chloride relationship (Appendix 8G, *Chloride*, Tables Cl-69 and Cl-70). These increases are extremely small in absolute terms and relative to applicable water quality objectives, and are within the estimated modeling uncertainty. The results differ from Alternative 4, under which there would be increased long-term average chloride concentrations also at the North Bay Aqueduct at Barker Slough. The change in long-term average chloride concentrations relative to the No Action Alternative (ELT) would be similar to those relative to Existing Conditions.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at Antioch and Contra Costa Pumping Plant #1. For Alternative 4A, the modeled frequency of objective exceedance would decrease at the Contra Costa Pumping Plant #1 from 7% of years under Existing Conditions, to 0% of years (Appendix 8G, *Chloride*, Table Cl-64).

Evaluation of the 250 mg/L Bay-Delta WQCP objective for chloride utilized results from both the mass balance approach and EC-chloride relationship. The basis for the evaluation was the predicted number of days the objective would be exceeded for the modeled 16-year period.

Based on the mass balance approach, there would be a decreased frequency of exceedance of the 250 mg/L objective under Alternative 4A, relative to Existing Conditions, at all locations except in the Sacramento River at Mallard Island and Emmaton, and San Joaquin River at Antioch. In the Sacramento River at Mallard Island, the frequency of objective exceedance would increase from 85% under Existing Conditions to 86% under Alternative 4A for the entire period modeled (Appendix 8G, *Chloride*, Table Cl-81). At Emmaton, there would be an increase in chloride objective exceedance during the drought period modeled, from 55% to 58%. In the San Joaquin River at Antioch, there would be an increase in the chloride objective exceedance during the drought period modeled from 82% to 83%. These changes are within the uncertainty of the modeling approach.

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 4A, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions, to 4% of modeled days under Alternative 4A (Appendix 8G, *Chloride*, Table Cl-63).

The mass balance results also indicate reduced assimilative capacity with respect to the 250 mg/L objective during certain months and at certain locations. In the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in March and April of up to 21% for the 16-year period modeled, and 71% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-71). Assimilative capacity at the Contra Costa Pumping Plant #1 would be reduced in March, April, and June by up to 4% for the entire period modeled and in April, May and June by up to 4% for the drought period modeled. These estimates include the effect of climate change and sea level rise, as well as the alternative. Comparisons to the No Action Alternative (ELT) below provide an assessment of the effect of the alternative alone.

When utilizing the EC-chloride relationship to model chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-72 and Cl-82). However, the EC-chloride relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

CWA Section 303(d) Listed Water Bodies–Relative to Existing Conditions

Tom Paine Slough in the southern Delta is on the state's CWA Section 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough, would be generally similar under Alternative 4A in the ELT relative to Existing Conditions, and thus, would not be further degraded on a long-term basis and Alternative 4A in the ELT would thus not make this impairment discernibly worse (Appendix 8G, *Chloride*, Figure Cl-17).

Suisun Marsh also is on the state's CWA Section 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. In the Sacramento River at Mallard Island, monthly average chloride concentrations for the 16-year period modeled would generally decrease under Alternative 4A in the ELT relative to Existing Conditions in October through February by 2–18%, and increase in March through May by 1–17% (Appendix 8G, *Chloride*, Figure Cl-18). In the Sacramento River at Collinsville monthly average chloride concentrations for the 16-year period modeled would similarly decrease under Alternative 4A in the ELT relative to Existing Conditions in October through February by 3–22% and increase in March and April by 11–21% (Appendix 8G, *Chloride*, Figure Cl-19). In Montezuma Slough at Beldon's Landing monthly average chloride concentrations for the 16-year period modeled would similarly decrease under Alternative 4A in the ELT relative to Existing Conditions in October through February by 1–15% and increase in March through May by 2–12% (Appendix 8G, *Chloride*, Figure Cl-20). Chloride levels in Suisun Marsh are highly dynamic on a sub-daily basis as a result of tidal influences. The changes identified above are small relative to normal day-to-day variability in chloride in Suisun Marsh. For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses. These changes reflect the effect of climate change and sea level rise, as well as the alternative. Comparisons to the No Action Alternative (ELT) below provide an assessment of the effect of the alternative alone.

Municipal Beneficial Uses Relative to No Action Alternative (ELT)

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated from EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 4A in the ELT, the modeled frequency of objective exceedance would not change at the Contra Costa Pumping Plant #1—both the No Action Alternative (ELT) and Alternative 4A would have no exceedances (Appendix 8G, *Chloride*, Table Cl-64).

Based on the mass balance approach, the frequency of exceedance of the 250 mg/L objective under Alternative 4A in the ELT would be the same, or would decrease, at all locations relative to the No Action Alternative (ELT) (Appendix 8G, *Chloride*, Table Cl-81).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 4A, the modeled frequency of objective exceedance would decrease, from 8% of modeled days under the No Action Alternative (ELT), to 4% of modeled days under Alternative 4A (Appendix 8G, *Chloride*, Table Cl-63).

Estimates of long-term use of assimilative capacity using the mass balance results indicated the potential for reduced assimilative capacity with respect to the 250 mg/L objective for certain months and locations. Calculations using the long-term monthly average concentrations showed that in the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in April of 5% for the entire period modeled and 48% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-71). However, this approach used long-term average chloride concentrations, which can be heavily influenced by changes in a small number of years when chloride concentrations would already be very high. Additionally, when long term averages are just below the objective, very small changes in chloride that are within the modeling uncertainty can result in very high estimates of use of assimilative capacity. To further investigate the potential for water quality degradation with respect to chloride, the concentrations of chloride during individual water years was examined.

This further examination was limited to the mass balance approach, since when utilizing the EC-chloride relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity were similar to those discussed for the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-82 and Cl-72). However, utilizing the EC-chloride relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Figure Cl-21 in Appendix 8G, *Chloride* shows chloride concentrations in April during the 5-year drought period (1987–1991) at Antioch, where Table Cl-71 in Appendix 8G, *Chloride* indicated up to 48% use of assimilative capacity. The figure shows that during 2 of the 5 years, chloride concentrations increased relative to the No Action Alternative (ELT) and decreased in the other 3 years. The absolute differences estimated are fairly small and may be within modeling uncertainty. Figures Cl-22 and Cl-23 in Appendix 8G show a box and whisker plot and exceedance plot for April at Antioch for all dry and critical water years modeled (not just the 1987–1991 drought period). These graphs show that while the median chloride concentration is increased relative to the No Action Alternative (ELT), the maximums, 25th percentile, and 75th percentile values are either similar or decreased. Based on this analysis, long-term degradation is not expected at Antioch in April during drought years.

Based on the low level of water quality degradation estimated for the western Delta, and the lack of exceedance of water quality objectives, Alternative 4A is not expected to have substantial adverse effects on municipal and industrial beneficial uses in the western Delta.

CWA Section 303(d) Listed Water Bodies–Relative to No Action Alternative (ELT)

With respect to the state's CWA Section 303(d) listing for chloride, monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis, based on the overall small changes that would occur in Old River at Tracy Road (Appendix 8G, *Chloride*, Figure Cl-17). In the Sacramento River at Mallard Island, monthly average chloride concentrations for the 16-year period modeled would increase slightly under Alternative 4A in the ELT relative to the No Action Alternative (ELT) in March and April by 1–4%, and decrease in May and October through February by up to 12% (Appendix 8G, *Chloride*, Figure Cl-18). In the Sacramento River at Collinsville monthly average chloride concentrations for the 16-year period modeled would similarly increase in March and April by 3%, and decrease in May and October through February by up to 18% (Appendix 8G, *Chloride*, Figure Cl-19). In Montezuma Slough at Beldon's Landing monthly average chloride concentrations for the 16-year period modeled would increase in December, March and April by 1–2%, and decrease in May, October, November, January and February by 6–10%(Appendix 8G, *Chloride*, Figure Cl-20). Chloride levels in Suisun Marsh are highly dynamic on a sub-daily basis as a result of tidal influences. The changes identified above are small relative to normal day-to-day variability in chloride in Suisun Marsh. For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses.

The effects of Alternative 4A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in chloride in the west Delta. Small increases in chloride concentrations may occur in some areas, but it is not expected that these increases would cause exceedance of Bay-Delta WQCP objectives of cause substantial long-term degradation that would impact municipal and industrial beneficial uses.

SWP/CVP Export Service Areas

Under Alternative 4A in the ELT, long-term average chloride concentrations at the Banks and Jones pumping plants, based on the mass balance analysis of modeling results for the 16-year period, would decrease relative to Existing Conditions. Chloride concentrations would be reduced by 45% at Banks pumping plant (Appendix 8G, *Chloride*, Table Cl-69). At Jones pumping plant, chloride concentrations would be reduced 43% (Appendix 8G, *Chloride*, Table Cl-69). The frequency of exceedances of applicable water quality objectives would decrease relative to Existing Conditions, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-81). The chloride concentration changes relative to the No Action Alternative (ELT) would be similar. Consequently, water exported into the SWP/CVP Export Service Areas would generally be of similar or better quality with regard to chloride relative to Existing Conditions and the No Action Alternative (ELT). Results of the modeling approach which utilized a EC-chloride relationship are consistent these results, and assessment of chloride using these modeling output results in the same conclusions as for the mass balance approach (Appendix 8G, *Chloride*, Tables Cl-70 and Cl-82).

Commensurate with the reduced chloride concentrations in water exported to the SWP/CVP Export Service Area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely reduce chloride concentrations at Vernalis.

The effects of Alternative 4A in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative (ELT and LLT), Alternative 4A would not result in substantially increased chloride concentrations upstream of the Delta, in the

Delta, or in the SWP/CVP Export Service Area on a long-term average basis that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Additional exceedance of the 150 mg/L and 250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Based on these findings, this effect is determined to not be adverse.

CEQA Conclusion**:** Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta; therefore, river flow rate and reservoir storage reductions that would occur under Alternative 4A relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, Alternative 4A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 4A would not result in substantially increased chloride concentrations in the Delta on a long-term average basis that would result in adverse effects on the municipal and industrial water supply beneficial use. Additional exceedance of the 150 mg/L and 250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use.

Chloride concentrations would be reduced under Alternative 4A in water exported from the Delta to the SWP/CVP Export Service Areas thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 4A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 4A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas

Based on these findings, this impact is determined to be less than significant. No mitigation is required. Despite the fact that no mitigation is required, DWR proposed to further reduce any impacts by implementing Mitigation Measure WQ-7e.

Mitigation Measure WQ-7e: Implement Terms of the Contra Costa Water District Settlement Agreement

DWR and Contra Costa Water District (CCWD) entered into a settlement agreement (Agreement) for reducing potential impacts to CCWD water supply in the Delta related to construction and operation of the BDCP/California WaterFix. This mitigation measure includes conveyance of water to CCWD that meets specified water quality requirements, in quantities and on a schedule defined in the Agreement. The Agreement ensures that the quality of the water CCWD delivers to its customers is not impacted as a result of the BDCP/California WaterFix. The Agreement does not increase the total amount of water that CCWD would otherwise be entitled to divert.

DWR would convey mitigation water to CCWD in one of two ways: 1) the primary method of conveying the water would be through the existing Freeport Regional Water Authority Intake (Freeport Intake) and the existing interconnection between EBMUD’s Mokelumne Aqueduct and CCWD’s Los Vaqueros Pipeline; and 2) the secondary method of conveying the water would be through the BDCP/California WaterFix’s northern intakes and new Interconnection Facilities between the water conveyance facilities and existing CCWD facilities. Two different options for the new Interconnection Facilities are being considered: one on Victoria Island between the water conveyance facilities and the existing CCWD Middle River pipeline; and one at Clifton Court Forebay between the Clifton Court Forebay and the CCWD Los Vaqueros pipeline. No new facilities are required for the EBMUD/Freeport Intake conveyance method. DWR would be responsible for design and construction of the Victoria Island or Clifton Court Forebay facilities.

The Agreement requires an initial conveyance to CCWD of 30 TAF of water. For each year after the initial conveyance, a specified amount of water based on the prior year's operations would be conveyed in arrears. Under the Agreement, CCWD would take the same quantity of water that it would take absent the agreement, but the location and timing of diversions would change. Annual average diversions of mitigation water would be on the order of 30 TAF, and the rate of diversion of the mitigation water would be 150 cfs, with a maximum rate of diversion of 250 cfs upon mutual agreement between DWR and CCWD.

Additional description of the Agreement actions and analysis of the potential effects of this mitigation measures are provided in Appendix 31B. Terms of the Agreement are presented in Attachment 1 to Appendix 31B.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Consequently, as they pertain to chloride, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement relative to the No Action Alternative (ELT and LLT). Therefore, the effects on chloride from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

***CEQA Conclusion*:** Implementation of the Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. Replacement of irrigated agricultural land uses in the Delta with habitat restoration may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance

As described in detail for Alternative 4 (see Section 8.3.3.9), DO levels are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

As described for Alternative 4, amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under Alternative 4A (ELT and LLT) to substantially alter DO levels relative to Existing Conditions or the No Action Alternative (ELT and LLT). Further, the rivers upstream of the Delta are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under Alternative 4A would not be expected to cause DO levels to be outside of the range seen historically. Flow changes that would occur under Alternative 4A would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative (ELT and LLT).

Also as described for Alternative 4, salinity changes would generally have relatively minor effects on Delta DO levels. Further, the relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative (ELT and LLT), such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses. Similarly, increased temperature under Alternative 4A (ELT and LLT), which would be due to climate change, would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Similar to Alternative 4, flows in the San Joaquin River at Stockton were evaluated for Alternative 4A and are shown in Figure 8-65b. The figure shows that while flows would change somewhat, they would generally be within the range of flows seen under Existing Conditions and the No Action Alternative. Reports indicate that the aeration facility performs adequately under the range of flows from 250–1,000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility would likely still be located appropriately to keep DO levels above Basin Plan objectives. Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial adverse effect on DO in the Deep Water Ship Channel. It is expected that DO levels in the Deep Water Ship Channel, which is CWA Section 303(d) listed as impaired due to low DO, would remain similar to those under Existing Conditions and the No Action Alternative (ELT and LLT) or improve as TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act Section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No Action Alternative (ELT and LLT), as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

In the SWP/CVP Export Service Areas, the primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions or the No Action Alternative (ELT and LLT) due to water quality regulations, canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

NEPA Effects: Because DO levels are not expected to change substantially relative to the No Action Alternative (ELT and LLT), the effects on DO from implementing Alternative 4A (ELT and LLT) are determined to not be adverse.

CEQA Conclusion: The effects of Alternative 4A on DO levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for Alternative 4 (see Section 8.3.3.9). Reservoir storage reductions that would occur under Alternative 4A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state regulates the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. The increased habitat provided by these Environmental Commitments could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying, though the areal extent of the effects would be less than under Alternative 4, because less land would be converted under Alternative 4A. The areal extent of new habitat implemented for the Environmental Commitments would be small relative to the existing and No Action Alternative tidal area, and similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), the amount expected would be minimal and only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta.

CM14, which under Alternative 4 would fund improvements to the oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would not be implemented under Alternative 4A. However, the existing aeration facility would continue to be operated to enhance DO levels in the channel. Thus, DO levels would be expected similar those under the No Action Alternative (ELT and LLT).

CM19, which under Alternative 4 would fund projects to contribute to reducing pollutant discharges in stormwater, also would not be implemented under Alternative 4A. Thus, the potential for reduced biochemical oxygen demand load described for Alternative 4 would not occur in the near-term and loading of these constituents and, thus DO levels, would be expected to be similar to that which would occur under the No Action Alternative (ELT and LLT).

The remaining Environmental Commitments would not affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances.

Based on the above findings, the effects on DO from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A are determined to not be adverse.

***CEQA Conclusion*:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would not be substantially different from existing DO conditions, because these would contribute to a minimal, localized change in oxygen-demanding substances associated with habitat restoration, if at all. Therefore, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 4A on EC levels in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). The extent of new urban growth would be less in the ELT, thus discharges of EC-elevating parameters in runoff and wastewater discharges to water bodies upstream of the Delta would be expected to be less than in the LLT. However, the state is regulating point source discharges of EC-related parameters and implementing a program to further decrease loading of EC-related parameters to tributaries. Based on these considerations, and those described in Section 8.3.3.9, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

For the San Joaquin River, increases in EC levels under Alternative 4A could occur, but would be slightly less than those described for Alternative 4 (see Section 8.3.3.9). This is because the effects of climate change on flows, which could affect dilution of high EC discharges, would be less in the ELT. The implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis are expected to contribute to improved EC levels. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions would not be expected to be of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Relative to Existing Conditions and the No Action Alternative (ELT), initial review of modeling results indicated that Alternative 4A would potentially result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton and San Joaquin River at Prisoners Point (Appendix 8H, *Electrical Conductivity*, Table EC-26). To understand and interpret these results, considerations must be made regarding uncertainty in the modeling and results from sensitivity analyses. In addition, modeling results indicate there would be small increases in long-term monthly average EC at modeled Suisun Marsh locations relative to Existing Conditions. These locations are addressed in detail below. At all other locations, the level of exceedance and modeled average EC levels under the alternative were approximately equivalent or lower than under Existing Conditions and the No Action Alternative (ELT).

Sacramento River at Emmaton

Modeling results indicated that the Emmaton EC objective would be exceeded more often under Alternative 4A than under Existing Conditions and the No Action Alternative (ELT), and that increases in EC could cause substantial water quality degradation in summer months of below normal, dry and critical water years. However, these increases in exceedance of the objective and degradation are expected to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Delta Cross Channel operation. Further discussion is provided below.

Modeling results indicated that the percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions, or 12% under the No Action Alternative (ELT), to 16%, and the percentage of days out of compliance would increase from 11% under Existing Conditions, or 21% under the No Action Alternative (ELT), to 27% (Appendix 8H, *Electrical Conductivity*, Table EC-26).

Sensitivity analyses were performed that modeled Alternative 4 Scenario H3 at the LLT with Emmaton as the compliance point. These sensitivity analyses were only run at the LLT, but it is expected that the findings can generally be extended to the ELT, because the factors affecting salinity findings in the sensitivity analysis (e.g., modeling assumptions, physical hydrodynamic mechanisms) are similar between the ELT and LLT (see Appendix 8H, *Electrical Conductivity*, Attachment 1). Table 2 of Appendix 8H, *Electrical Conductivity*, Attachment 1, indicates that most of these exceedances are a result of modeling artifacts, but some exceedances are due to deadpool conditions that occurred under Alternative 4 and not under the No Action Alternative. As discussed in Chapter 5, *Water Supply*, Section 5.3.1, *Methods for Analysis*, under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, CALSIM II uses a series of operating rules to reach a solution that is a simplified version of the very complex decision processes that SWP and CVP operators would use in actual extreme conditions. Thus, it is unlikely that the Emmaton objective would actually be exceeded due to dead pool conditions. However, these results indicate that water supply could be either under greater stress or under stress earlier in the year.

The results of the EC modeling indicate there would be months with substantial degradation relative to the No Action Alternative (ELT), particularly during the drought period modeled. Long-term monthly average EC levels at Emmaton would increase in the months of April, and July through September by 3–30% for the entire period modeled (1976–1991) and 6–41% during the drought period modeled (1987–1991), relative to the No Action Alternative (ELT) (Appendix 8H, *Electrical Conductivity*, Table EC-29). The largest increases in EC would occur in below normal, dry and critical water year types. However, as stated above, these periods of degradation are expected to be addressed via real-time operations. The level to which modeling output depicts degradation of water quality with respect to EC is primarily a function of the modeling not being able to fully capture how the system would be operated in real-time to minimize or avoid such degradation.

Discussions with SWP operators indicated that real-time operations would ensure that the Bay-Delta WQCP EC objectives at Emmaton, applicable from April 1 through August 15, would be met. In latter August and September, the Threemile Slough standard in the North Delta Water Agency Agreement and the Bay-Delta WQCP municipal and industrial objective at Rock Slough are in effect. During this period of the year, the coordinated operations of the SWP/CVP system strives to meet both standards in the most water-efficient method available to the CVP and SWP. Real-time operation would result in less EC degradation than depicted by modeling output because in order to comply with Bay-Delta WQCP objectives and the the North Delta Water Agency Agreement during the summer period, operators could, for example, increase upstream reservoir releases for necessary periods of time, reduce North Delta diversions, and/or close (short-term) the Delta Cross Channel. These options as well as real-time and forecasted tides, winds and barometric pressure are considered when the projects schedule daily operations, which the modeling does not fully capture.

Alternaltive 4A does not change the Bay-Delta WQCP objectives or the the North Delta Water Agency Agreement which are primary drivers of operations and resulting water quality in the Sacramento River at at Emmaton during late August and September. Therefore, the EC degradation at Emmaton that would occur upon implementation of Alternative 4A would be lesser than that shown by the modeling and would not be expected to differ substantially from that which would occur under the No Project Alternative because the compliance targets are not changing due to Alternative 4A during these months and real-time operations would achieve the compliance targets.

The modeling results also show that in the remaining months there would be decreases in EC relative to the No Action Alternative (ELT) of 3–21% for the entire period modeled and 2–28% for the drought period modeled. These decreases would contribute to the long-term average EC levels decreasing by 1% for the entire period modeled and drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-29).

San Joaquin River at Prisoners Point

Modeling results indicated that the EC objective that applies to the San Joaquin River between Jersey Point and Prisoners Point would be exceeded at Prisoners Point more often under Alternative 4A than under Existing Conditions and the No Action Alternative (ELT). However, these exceedances also are expected to be able to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Head of Old River Barrier management. Further discussion is provided below.

Modeling results estimated that the percentage of days the Prisoners Point EC objective would be exceeded would increase from 6% under Existing Conditions, or 2% under the No Action Alternative (ELT), to 12%, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions, or 2% under the No Action Alternative (ELT), to 13% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The magnitude of the exceedances is estimated to be very small—the objective is 440 µmhos/cm, and the EC during times of exceedance was between 440 and 600 µmhos/cm—and the exceedances generally occurred in drier water years (4 of the 5 years in which there were exceedances were dry water year type), when flows would be lower (Appendix 8H, *Electrical Conductivity*, Figures EC-1 through EC-5). During these times, the EC in the San Joaquin River at Vernalis is greater than in the Sacramento River entering the Delta, and is high enough on its own to cause an exceedance of the Prisoners Point EC objective.

There are two main drivers of the increase in exceedances under the alternative: an increase in San Joaquin River flow at Prisoners Point during April and May under the alternative, relative to Existing Conditions and the No Action Alternative (ELT), and a reduction in the amount of Sacramento River water moving past Prisoners Point under the alternative. The result is increased San Joaquin River water at Prisoners Point, and a reduction in the dilution that the Sacramento River provides the higher EC San Joaquin River. The increase in San Joaquin River flow at Prisoners Point is due to a reduction in pumping from the south Delta under the alternative, as well as due to the presence of the Head of Old River Barrier, which increases flow in the San Joaquin River downstream of Old River by preventing flow from entering Old River. The reduction in Sacramento River water influence is due to less pumping at the south Delta pumping plants (i.e., greater pumping draws more Sacramento River water through the Delta).

Sensitivity analyses conducted for Alternative 4 Scenario H3 at the LLT indicated that if the Head of Old River Barrier was open in April and May, exceedances would be reduced by about 5 percentage points. These sensitivity analyses were only run at the LLT, but it is expected that the findings can generally be extended to the ELT. Results of the sensitivity analyses indicate that the exceedances are partly due also to operations of the alternative itself, due to Head of Old River Barrier assumptions, and south Delta export differences (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of exceedances estimated via modeling adversely affecting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination for those alternatives. Additionally, by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, EC levels at Prisoners Point would likely be decreased to a level that would not adversely affect aquatic life beneficial uses.

Suisun Marsh

For Suisun Marsh October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Modeling results indicate that average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March and April relative to Existing Conditions, by 0.1–0.2 mS/cm (Appendix 8H, *Electrical Conductivity*, Table EC-32). In Montezuma Slough at National Steel, average EC levels would increase in March through May by 0.2 mS/cm (Appendix 8H, Table EC-33). There would be similarly small increases in long-term average EC in the months of March through May in Montezuma Slough near Beldon's Landing, Chadbourne Slough near Sunrise Duck Club, and Suisun Slough near Volanti Slough, ranging 0.1–0.4 mS/cm depending on month and location (Appendix 8H, Tables EC-34 through EC-36). Relative to the No Action Alternative (ELT), the modeled long-term average EC under the alternative would be similar or lower from October through May for these locations (Appendix 8H, Tables EC-32 through EC-36).

The Suisun Marsh EC objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). Long-term average EC increases relative to Existing Conditions may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the Marsh. Given the Bay-Delta WQCP narrative objective regarding "equivalent or better protection" in lieu of meeting specific numeric objectives, the small increases in EC under Alternative 4A, relative to Existing Conditions, would not be expected to adversely affect beneficial uses of Suisun Marsh. While Suisun Marsh is CWA Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) relative to the daily fluctuations in EC levels as to not be measurable and beneficial uses would not be adversely affected.

Further, the EC changes in Suisun Marsh relative to Existing Conditions reflect the influence of both operations of the alternative and sea level rise due to climate change, whereas the changes relative to the No Action Alternative (ELT) are due solely to operations of the alternative. As described above, there would be no increase in the long-term average EC at modeled Suisun Marsh locations, and for some locations long-term average EC would decrease. Therefore, it is expected that this alternative would not contribute to exceedances of EC objectives or additional impairment of beneficial uses, as affected by EC or other salinity-related parameters.

The effects of Alternative 4A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in EC in the west Delta, but this requirement would not be due to the alternative.

SWP/CVP Export Service Areas

Under Alternative 4A, at the Banks pumping plant, the frequency of exceedance of the EC objective would be 1% for the entire period modeled and 2% for the drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-27). Relative to Existing Conditions, average EC levels under

Alternative 4A would decrease 25% for the entire period modeled and 20% during the drought period modeled (Appendix 8H, Table EC-29). Relative to the No Action Alternative (ELT), average EC levels would similarly decrease, by 22% for the entire period modeled and 18% during the drought period modeled (Appendix 8H, Table EC-29).

At the Jones pumping plant, the frequency of exceedance of the EC objective would be 0% for the entire period modeled and the drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-27). Relative to Existing Conditions, average EC levels under Alternative 4A would decrease 26% for the entire period modeled and 24% during the drought period modeled (Appendix 8H, Table EC-29). Relative to the No Action Alternative (ELT), average EC levels would similarly decrease, by 23% for the entire period modeled and 21% during the drought period modeled (Appendix 8H, Table EC-29).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 4A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas. Rather, Alternative 4A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 4A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative (ELT) and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

The effects of Alternative 4A in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

NEPA Effects: In summary, based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the western, interior, or southern Delta. However, modeling results indicate that there could be increased long-term and drought period average EC levels during the summer months that would occur in the western Delta (i.e., in the Sacramento River at Emmaton) under Alternative 4A relative to the No Action Alternative (ELT), that could contribute to adverse effects on the agricultural beneficial uses. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to increase under Alternative 4A, relative to the No Action Alternative (ELT), and thus it is not expected to contribute to additional beneficial use impairment. The increases in EC in the Sacramento River at Emmaton, particularly during summer months of below normal, dry and critical water years, and the additional exceedances of water quality objectives in the San Joaquin River at Prisoners Point constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects so that they are not adverse.

CEQA Conclusion**:** River flow rate and reservoir storage reductions that would occur under Alternative 4A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 4A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas, and exceedance of the Bay-Delta WQCP EC objective would be infrequent. Average EC levels for the entire period modeled would decrease at both the Banks and Jones pumping plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Further, relative to Existing Conditions, Alternative 4A would not result in substantial increases in long-term average EC in Suisun Marsh. Thus, EC levels in Suisun Marsh are not expected to further degrade existing EC levels and thus would not contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, any changes in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to change substantially under Alternative 4A, relative to Existing Conditions, and thus it is not expected that they would contribute to additional beneficial use impairment.

In the Plan Area, Alternative 4A is not expected to result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded, except for at the San Joaquin River at Prisoners Point (fish and wildlife objective; 6% increase). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. However, by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, EC levels at Prisoners Point would likely be decreased to a level that would not adversely affect aquatic life beneficial uses.

Average EC levels at Emmaton were modeled to increase by 9% during the drought period. The largest monthly average increases in EC would occur during the summer months of the drought period, and more generally in below normal, dry and critical water year types. The increases in drought period average EC levels modeled could cause substantial water quality degradation that would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The comparison to Existing Conditions reflects changes in EC due to both Alternative 4A operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton would be due in part to the effects of climate change/sea level rise, and in part due to Alternative 4A operations. This is evidenced by the increases in EC in the No Action Alternative (ELT) at Emmaton relative to Existing Conditions, as well as the fact that a lesser level of adverse effects is expected at

Emmaton under Alternative 4A relative to the No Action Alternative (ELT). During summer of below normal, dry and critical water years, additional flow in the Sacramento River at Emmaton would reduce or eliminate increases in EC. It is expected that for July–September of below normal, dry and critical water years, real-time operations that would include more precise management of upstream reservoir realeases on a daily basis and less pumping from the north Delta intakes and greater reliance on south Delta intakes than that modeled would allow for enough flow in the Sacramento River at Emmaton to reduce water quality degradation to levels closer to the No Action Alternative that would not be expected to adversely affect beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is CWA Section 303(d) listed for elevated EC and the increased EC degradation that was modeled in the western Delta could make beneficial use impairment measurably worse.

Based on these findings, this impact in the Plan Area is considered to be significant. Implementation of Mitigation Measure WQ-11 would be expected to reduce these effects to a less-than-significant level.

Mitigation Measure WQ-11: Avoid or Minimize Reduced Water Quality Conditions

The implementation of mitigation actions shall be focused on avoiding or minimizing those incremental effects attributable to implementation of Alternative 4A operations only. Mitigation actions to avoid or minimize the incremental EC effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4A. The goal of specific actions is to reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average EC concentration increases to levels that would not adversely affect beneficial uses within the Delta, and would not make beneficial use impairment measurably worse. Implementation of Mitigation Measure WQ-11 would be expected to reduce effects on EC to a less-than-significant level.

Mitigation Measure WQ-11e: Implement Real-time Operations, Including Adaptively Managing Diversions at the North and South Delta Intakes, to Reduce or Eliminate Water Quality Degradation in the Western Delta

Modeling results for Alternative 4A indicate water quality degradation for EC in the Sacramento River at Emmaton in the months of July through September of below normal, dry and critical water year types, relative to the No Action Alternative (ELT). This mitigation measure establishes performance standards to address the modeled exceedances of Bay-Delta WQCP EC objectives and EC degradation such that impacts to beneficial uses affected by remaining degradation, following mitigation, would be less than significant.

The Bay-Delta WQCP establishes water quality objectives for EC at Emmaton applicable from April 1 through August 15 for the protection of agricultural beneficial uses. To address exceedances of Bay-Delta WQCP EC objectives and EC degradation at Emmaton that has been modeled to occur in July and the first half of August of below normal, dry, and critical water years, the project proponents shall rely upon real-time operations (which cannot be fully captured in the modeling) to ensure that Bay-Delta WQCP Emmaton EC objectives are met. As a component of real-time operations, the project proponents shall ensure adequate releases from upstream reservoirs on a daily time-step and adaptively manage the split between north and south Delta diversions to achieve the Bay-Delta WQCP EC objectives at Emmaton. The project proponents are required to operate to meet these objectives under Existing Conditions, and would be required to operate to these objectives under the No Action Alternative. Thus, operation of the project alternative to achieve the Bay-Delta WQCP EC objectives would be consistent with Existing Conditions and the No Action Alternative and result in a minimization of EC degradation at Emmaton during July and and the first half of August of below normal, dry, and critical water year types. Hence, the performance standard for July and the first half of August shall be the Bay-Delta WQCP Emmaton EC objectives.

The Bay-Delta WQCP does not establish an EC objective at Emmaton for the latter half of August or September. To address EC degradation at Emmaton that has been modeled to occur during this period of the year with the project alternative, the project proponents shall manage upstream reservoir releases on a daily basis and adaptively manage the split between north and south Delta diversions of below normal, dry and critical water years. The performance standard for late August and September shall be compliance with the Threemile Slough standard in the North Delta Water Agency Agreement and the Bay-Delta WQCP municipal and industrial objective at Rock Slough as implemented within Decision 1641 or as modified in the future. Allowing sufficient flow in the Sacramento River at Emmaton, through real-time operations, would contribute to reduced EC levels at this location, relative to that modeled for the project alternative, and would reduce EC degradation at Emmaton in late August and September to less-than-significant levels.

This mitigation measure is consistent with the adaptive management and real-time operations that would be utilized to minimize the project alternative's water quality effects to *Microcystis* in the summer months (discussed in Impact WQ-32). This mitigation measure also is consistent with the Other (Non-Environmental) Commitment to address reverse flows in the Sacramento River at Freeport that may occur with the project alternative, which are most likely to occur in low flow months of dry and critical years.

Mitigation Measure WQ-11f: Adaptively Manage Head of Old River Barrier and Diversions at the North and South Delta Intakes to Reduce or Eliminate Exceedances of the Bay-Delta WQCP Objective at Prisoners Point

Modeling results for Alternative 4A indicated additional exceedances of the Bay-Delta WQCP objective for protection of striped bass between Jersey Point and Prisoners Point, at Prisoners Point. It is expected that by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, exceedances of the EC objective at Prisoners Point could be avoided, and EC levels at Prisoners Point would be decreased to a level that would not adversely affect aquatic life beneficial uses. The project proponents shall adaptively manage the Head of Old River Barrier and the split between north and south Delta diversions during April-May to avoid exceedances of the objective at Prisoners Point. These actions would not be required in critical water years, when the objective does not apply. The project proponents will consult with CDFW, USFWS, NMFS, and Reclamation to ensure that such actions are warranted to avoid adverse impacts of salinity on striped bass spawning in the San Joaquin River between Jersey Point and Prisoners Point, and to minimize adverse effects these mitigation actions may have on other species. As such, the mitigation performance standard for April and May shall be compliance with the Bay-Delta WQCP EC objective at Prisoners Point.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15 and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

Environmental Commitment 4 would result in some tidal habitat restoration; however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable EC changes.

In summary, implementation of the Environmental Commitments would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment. Therefore, the effects on EC from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would not present new or substantially changed sources of EC to the affected environment. Some Environmental Commitments may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters, because agricultural drainage can be a source of elevated EC. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the Alternative 4A on mercury levels in surface waters upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT) would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors that affect mercury concentrations in surface waters upstream of the Delta are similar under Alternatives 4 and 4A. The changes in flow in the Sacramento River under Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) would not be of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore, mercury loading should not be substantially different due to changes in flow. In addition, even though they may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but would not change substantially because the anticipated changes in flow are not expected to substantially change mercury loading relative to Existing Conditions or the No Action Alternative (ELT).

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

Delta

The effects of Alternative 4A on waterborne concentrations of mercury (Appendix 8I, *Mercury*, Table I-17) and methylmercury (Appendix 8I, Table I-18), and fish tissue mercury concentrations for largemouth bass fillet (Appendix 8I, Tables I-20a and I-20b) were evaluated for nine Delta locations.

Increases in long-term average mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) would be very small, 0.3 ng/L or less. Also, use of assimilative capacity for mercury relative to the 25 ng/L ecological threshold under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT), would be very low, about 2% or less, as a long-term average, for all Delta locations (Appendix 8I, *Mercury*, Table I-23). These concentration changes and small changes in assimilative capacity for mercury are not expected to result in adverse (or positive) effects to beneficial uses.

Changes in methylmercury concentrations in water also are expected to be very small. The greatest annual average methylmercury concentration under Alternative 4A would be 0.166 ng/L for the San Joaquin River at Buckley Cove, for the drought period modeled, which would be slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (ELT) (0.168 ng/L) (Appendix 8I, *Mercury*, Table I-18). All methylmercury concentrations in water were estimated to exceed the TMDL guidance objective of 0.06 ng/L under Existing Conditions and, therefore, no assimilative capacity exists.

Fish tissue estimates for largemouth bass fillet show small or no increases in mercury concentrations under Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, *Mercury*, Tables I-20a and I-20b). Concentrations expected for Alternative 4A with Equation 1 show increases of 6% or less relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, Table I-20a). Concentrations expected for Alternative 4A with

Equation 2 show increases of 8% or less relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, Table I-20b). Concentrations expected for Alternative 4A with Equation 1 show decreases of 1% relative to Existing Conditions at the North Bay Aqueduct at Barker Slough Pumping Plant in all years and 1% relative to the No Action Alternative at San Joaquin River at Buckley Cove in all years and the drought period (Appendix 8I, *Mercury*, Table I-20a). Concentrations expected for Alternative 4A with Equation 2 show decreases in the North Bay Aqueduct at Barker Slough relative to Existing Conditions in all years of 1%, and a decrease of 2% relative to the No Action Alternative (ELT) in all years and the drought period (Appendix 8I, Table I-20b).

Because the increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I, *Mercury*, for a complete discussion of the uncertainty associated with the fish tissue estimates. Briefly, the bioaccumulation models contain multiple sources of uncertainty associated with their development. These are related to analytical variability; temporal and/or seasonal variability in Delta source water concentrations of methylmercury; interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and limited sample size (both in number of fish and time span over which the measurements were made), among others. Although there is considerable uncertainty in the models used, the results serve as reasonable approximations of a very complex process. Considering the uncertainty, small (i.e., < 20–25%) increases or decreases in modeled fish tissue mercury concentrations at a few Delta locations (i.e., 2–3) should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual adverse effects. Larger increases, or increases evident throughout the Delta, can be interpreted as more reliable indicators of potential adverse effects.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 4A at the Jones and Banks pumping plants, would be lower than Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, *Mercury*, Tables I-17 and I-18). Therefore, mercury shows an increased assimilative capacity at these locations (Appendix 8I, Table I-23).

The largest improvements in bass tissue mercury concentrations and exceedance quotients ([EQs]; modeled tissue divided by TMDL guidance concentration) for Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT) at any location within the Delta, are expected for the Banks and Jones pumping plant export pump locations. Concentrations expected for Alternative 4A at the export pump locations with Equation 1 in all years show decreases relative to Existing Conditions (8% to 10%) and relative to the No Action Alternative (ELT) (9% to 11%) (Appendix 8I, *Mercury*, Table I-20a). Concentrations expected for Alternative 4A with Equation 2 in all years show decreases at Banks and Jones pumping plants relative to Existing Conditions (11% to 14%) and the No Action Alternative (ELT) (13% to 15%) (Appendix 8I, Table I-20b).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

NEPA Effects: Based on the above discussion, Alternative 4A would not cause concentrations of mercury and methylmercury in water and fish tissue in the affected environment to be substantially different from the No Action Alternative (ELT and LLT) and, thus, would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to the No Action Alternative (ELT and LLT), Alternative 4A would not be expected to increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, the effects of Alternative 4A on mercury in the affected environment are considered to be not adverse.

CEQA Conclusion: Under Alternative 4A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta would not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury over the period of record under Alternative 4A would be very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show that small differences would occur among sites for Alternative 4A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP/CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 4A, as compared to Existing Conditions.

As such, Alternative 4A is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 4A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The potential types of effects on mercury resulting from implementation of the Environmental Commitments under Alternative 4A would be generally similar to those described under Alternative 4 (see Section 8.3.3.9). However, the magnitude of effects on mercury and methylmercury at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service Areas related to habitat restoration would be considerably lower than described for Alternative 4. This is because the amount of habitat restoration to be implemented under Alternative 4A would be very low compared to the total proposed restoration area that would be implemented under Alternative 4. The small amount of habitat restoration to be implemented under Alternative 4A may occur on lands in the Delta formerly used for irrigated agriculture. Habitat restoration proposed under Alternative 4A has the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the vicinity of the restored habitat areas. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, there remain uncertainties related to site-specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta in the vicinity of the restored areas. Therefore, the effect of Environmental Commitments 3, 4, 6–12, 15, and 16 on mercury and methylmercury is considered to be adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. However, in the Delta, due to the small amount of tidal restoration areas proposed, relative to Existing Conditions, uptake of mercury from water and/or methylation of inorganic mercury may increase in localized areas as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Although not quantifiable, on a local level, increases in methylmercury concentrations may be measurable. Methylmercury is CWA Section 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant because, as described above, any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. No mitigation measures would be available until specific restoration actions are proposed. Therefore, this impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (in Section 8.3.3.9), nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the reservoirs and rivers relative to the magnitude of the point and non-point source discharges, and there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions or the No Action Alternative (ELT), are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento River watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49; Figure 2 in Appendix 8J, *Nitrate*). Under Alternative 4A, long-term average flows at Vernalis would decrease an estimated 1% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (ELT). Given the relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any negligible changes in nitrate concentrations that may occur under Alternative 4A in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to nitrate.

Delta

Mass balance calculations indicate that under Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 34). Although changes at specific Delta locations and for specific months may be substantial on a relative basis (Appendix

8J, Table 37), the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds (see *Nitrate* under Section 8.3.1.7, *Constituent-Specific Considerations Used in the Assessment*). Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 Delta assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentrations would be somewhat reduced under Alternative 4A relative to Existing Conditions, and slightly increased relative to the No Action Alternative (ELT). No additional exceedances of the MCL are anticipated at any location under Alternative 4A (Appendix 8J, Table 34).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under Alternative 4A would be low or negligible (i.e., <4%) in comparison to both Existing Conditions and the No Action Alternative (ELT), for all locations and months, for all modeled years (1976–1991), and for the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 38).

As described for Alternative 4, actual nitrate concentrations would likely be higher than the modeling results indicate in certain locations under Alternative 4A. This is the mass balance modeling does not account for contributions from the SRWTP, which would be implementing nitrification/partial denitrification, or Delta wastewater treatment plant dischargers that practice nitrification, but not denitrification. However, as described for Alternative 4, any increases in nitrate concentrations that may occur at certain locations within the Delta under Alternative 4A would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to nitrate.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Assessment of effects of Alternative 4A on nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate at the Banks and Jones pumping plants. Relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations at Banks and Jones pumping plants under Alternative 4A are anticipated to decrease on a long-term average annual basis by 27% at the Banks pumping plant and 29% at the Jones pumping plant (Appendix 8J, *Nitrate*, Table 37). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) would be small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Areas, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.2 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP/CVP Export Service Areas. No additional exceedances of the MCL are anticipated under Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8J, *Nitrate*, Table 34). On a monthly average basis and on a long-term annual average basis, for all modeled years and for the drought period only, use of assimilative capacity available under Existing Conditions and the No Action Alternative (ELT), relative to the 10 mg/L-N MCL, would be negligible (<2%) for both Banks and Jones pumping plants (Appendix 8J, Table 38).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any increases in nitrate concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regard to nitrate.

NEPA Effects: Modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. In the Delta, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any Delta location, and use of assimilative capacity available under the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, would be low. Long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to differ negligibly relative to the No Action Alternative (ELT and LLT) and no additional exceedances of the 10 mg/L-N MCL are anticipated. Therefore, the effects on nitrate from implementing water conveyance facilities are considered to be not adverse.

CEQA Conclusion: Nitrate concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers).Although higher in the San Joaquin River watershed, nitrate concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mass balance calculations indicate that under Alternative 4A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, would be low or negligible (i.e., <4%) for all for virtually all locations and months.

Assessment of effects of nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate concentrations at the Banks and Jones pumping plants. Results of the mass balance calculations indicate that under Alternative 4A relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the 10 mg/L-N MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL would be negligible (i.e., <2%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under Alternative 4A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Some habitat restoration activities included in Environmental Commitments 3, 4, and 6–11 would occur on lands within the Delta formerly used for agriculture. As discussed for Impact WQ-2, increased biota that may result in those areas may increase ammonia, which in turn may be converted to nitrate by established microbial communities. However, the areal extent of new habitat implemented for the Environmental Commitments would be less than the existing and No Action Alternative habitat areas, and similar habitat exists currently in the Delta and is not identified as contributing to adverse nitrate conditions. Thus, these land use changes would not be expected to substantially increase nitrate concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect nitrate sources or loading. Based on these findings, the effects on nitrate from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

***CEQA Conclusion*:** Land use changes that would occur from the Environmental Commitments are not expected to substantially increase nitrate concentrations, because the amount of area to be converted would be small relative to existing habitat, and existing habitats are not known for contributing to adverse nitrate conditions. Thus, it is expected that implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 4A on DOC concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 because factors affecting DOC concentrations (e.g., source and non-point source inputs) in these water bodies would be similar. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under Alternative 4A would not be expected to cause substantial long-term changes in DOC concentrations in the water bodies upstream of the Delta. Any changes in DOC levels in water bodies upstream of the Delta under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies.

Delta

Under Alternative 4A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that described for Alternative 4, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be lower. The effects of Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action Alternative (ELT), Alternative 4A would result in small increases in long-term average DOC concentrations for both the modeled 16-year period (1976–1991) and drought period (1987–1991) at several interior Delta locations (increases up to 0.2 mg/L at the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1) (Appendix 8K, *Organic Carbon*, Table DOC-11). The increases in average DOC concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at the Contra Costa Pumping Plant #1 location exceeding the 3 mg/L threshold (i.e., increase from 52% under Existing Conditions to 64% under Alternative 4A for the modeled 16-year period). The change in frequency of threshold concentration exceedances at other assessment locations would be similar or lower.

While Alternative 4A would lead to slightly higher long-term average DOC concentrations at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. As discussed for Alternative 4, substantial changes in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 4A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Relative to Existing Conditions and the No Action Alternative (ELT and LLT), Alternative 4A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below).

SWP/CVP Export Service Areas

Under the Alternative 4A, long-term average DOC concentrations would decrease at Barker Slough by 0.1 mg/L, and at both the Banks and Jones pumping plants by 0.4 mg/L, relative to Existing Conditions. Reductions would be similar compared to No Action Alternative (ELT) (Appendix 8K, *Organic Carbon*, Table DOC-11). Decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedances of the 3 mg/L threshold during the modeled drought period would increase at the Banks and Jones pumping plants. Relative to Existing Conditions, exceedance of the 3 mg/L threshold would increase from 57% to 72% at Banks pumping plant and from 72% to 88% at Jones pumping plant. There would be little to no increase in exceedance of the 3 mg/L threshold relative to the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Maintenance of SWP and CVP facilities under Alternative 4A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area.

NEPA Effects: In summary, the operations and maintenance activities under Alternative 4A, relative to the No Action Alternative (ELT and LLT), would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. The long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by 0.4 mg/L, while long-term average DOC concentrations for some Delta interior locations are predicted to increase by as much as 0.2 mg/L. However, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. Based on these findings, the effect of operations and maintenance activities on DOC under Alternative 4A is determined to be not adverse.

CEQA Conclusion: For the same reasons described for Alternative 4, the operations and maintenance activities under Alternative 4A, relative to the Existing Conditions, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. Any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DOC levels upstream of the Delta. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the Alternative 4A would result in relatively small increases (i.e., ≤0.2 mg/L) in long-term average DOC concentrations at some interior Delta locations. The predicted increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. Because this alternative would lead to only slightly higher long-term average DOC concentrations at the interior Delta locations and some municipal water intakes, the predicted changes would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

Relative to Existing Conditions, the Alternative 4A would result in reduced long-term average DOC concentrations at the Banks and Jones pumping plants and Barker Slough. However, Alternative 4A would result in slightly greater frequency of exceedance of the 3 mg/L DOC concentration threshold during the modeled drought period. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Alternative 4A would not result in any substantial change in long-term average DOC concentration. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

The potential types of effects on DOC resulting from implementation of the Environmental Commitments under Alternative 4A would be generally similar to those described under Alternative 4 (see Section 8.3.3.9). However, the magnitude of effects on DOC at locations upstream of the Delta, in the Delta, and the SWP/CVP export service areas would be considerably lower than described for Alternative 4.

As described for Alternative 4, Environmental Commitments 3, 9, 11, 12, 15, and 16 would present no major sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area that would adversely affect beneficial uses. Environmental Commitments 4, 6, 7, and 10 include habitat restoration activities known to be sources of DOC. However, the amount of new habitat restoration to be implemented would be very small compared to the areal extent of existing habitat and that proposed for the No Action Alternative. Based on the amount of habitat restoration proposed, DOC loading from these areas would be very low in these water bodies. Consequently, relative to the Existing Conditions and No Action Alternative (ELT and LLT), the potential DOC loading to the Delta would be minimal, and thus not contribute substantially to the amounts of DOC in raw drinking water supplies.

NEPA Effects: Relative to existing habitat and that to be developed under the No Action Alternative (ELT and LLT), the area of new habitat restoration implemented for the Environmental Commitments would be very small. Implementation of non-habitat restoration Environmental Commitments would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, any increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Based on these findings, the effect of the Environmental Commitments on DOC is determined to be not adverse.

CEQA Conclusion: Implementation of habitat restoration Environmental Commitments is not expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas, relative to the Existing Conditions, because the land area proposed for restoration would be relatively small compared to existing land area and sources of DOC. Implementation of other Environmental Commitments also would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 4A on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). As described for Alternative 4, pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers. Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows and that pathogen concentrations in the rivers have a minimal relationship to river flow rate, river flow rate and reservoir storage reductions that would occur under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta.

The effects of Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed. However, as described for Alternative 4, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens, because it is expected that pathogen sources in close proximity to Delta sites would have a greater influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

As such, Alternative 4A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

NEPA Effects: Because pathogen levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on pathogens from implementing Alternative 4A are determined to be not adverse.

CEQA Conclusion: The effects of Alternative 4A on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because the factors that would affect pathogen levels in the surface waters of these areas would be similar. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative (ELT and LLT). The geographic extent of the potential increases would be less than under Alternative 4, because less land would be converted under Alternative 4A. The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

The remaining Environmental Commitments would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources.

Based on these findings, the effects on pathogens from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of Environmental Commitments 3, 4, and 6–11 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The geographic extent of the increase would be less than under Alternative 4, because less land would be converted under Alternative 4A. The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 4A operations and maintenance on pesticide levels in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT), would be similar to those expected to occur under Alternative 4 (see Section 8.3.3.9). This is because under Alternative 4A, the primary factor that would influence pesticide concentrations in surface waters upstream of the Delta—the effect of timing and magnitude of reservoir releases on dilution capacity—is expected to change by a similar degree. Changes in average winter and summer flow rates, relative to Existing Conditions and the No Action Alternative (ELT), are expected to be similar to or less than changes in flow rates expected under Alternative 4 in the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis (Appendix 8L, *Pesticides,* Tables 1 through 4). Similarly, the primary factor that would influence pesticide concentrations in surface waters of the Delta and in the SWP/CVP Export Service Areas (i.e., changes in San Joaquin River, Sacramento River and Delta agriculture source water fractions at various Delta locations, including Banks and Jones pumping plants) is expected to change by a similar degree. The percentage change in monthly average source water fractions would be similar to changes expected under Alternative 4 (Appendix 8D, *Source Water Fingerprinting Results*).

It was concluded for Alternative 4, and thus for Alternative 4A based on similar flow changes, that the potential average summer flow reductions would not be of sufficient magnitude to substantially increase in-river pesticide concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses upstream of the Delta. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered. Similarly, the modeled changes in the source water fractions of Sacramento River, San Joaquin River, and Delta agriculture water under Alternative 4A would not be of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of organophosphate insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

The flow changes in the LLT would be expected in the ranges of that described above for Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT), and that described for Alternative 4 relative to the No Action Alternative (LLT) in Section 8.3.3.9. Thus, similar to above and Alternative 4, the flow changes that would occur in the LLT under Alternative 4A, relative to Existing Conditions and the No Action Alternative (LLT), would not be expected to result in changes in dilution of pesticides of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses upstream of the Delta, in the Delta, or the SWP/CVP Export Service Areas.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers under Alternative 4A relative to the No Action Alternative (ELT and LLT) would be of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, changes in source water fractions to the Delta would be of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP Export Service Areas. Therefore, the effects on pesticides from the water conveyance facilities are determined not to be adverse.

***CEQA Conclusion*:** Based on the discussion above, the effects of Alternative 4A on pesticide levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or slightly less than those described for the Alternative 4. Alternative 4A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous CWA Section 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under

Alternative 4A would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

As described for Alternative 4 (see Section 8.3.3.9), Environmental Commitments 3, 4, and 6–11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Environmental Commitments 12, 15, and 16 do not include actions that would affect pesticide sources or loading. Unlike under Alternative 4, *CM13 Invasive Aquatic Vegetation Control* and *CM19 Urban Stormwater Treatment* would not be implemented. Because of this, benefits to water quality from treatment measures that would reduce pesticide loading from urban land uses, as well as adverse impacts to water quality from application of herbicides directly to waters in the plan area that would occur under Alternative 4 would not occur under Alternative 4A.

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly. Therefore, relative to the No Action Alternative (ELT and LLT), the effects on pesticides from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly, such that pesticide levels would differ little from Existing Conditions. Therefore, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increases in pesticide concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas. As such, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pesticide concentrations are not expected to increase substantially, no long-term water quality degradation for pesticides is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term pesticide concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. Environmental Commitments 3, 4, 6–12, 15, 16 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the Environmental Commitments propose the use of any pesticide currently named in a CWA Section 303(d) listing of the affected environment. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 4A on phosphorus concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors which affect phosphorus concentrations in surface waters of these areas are the same under Alternative 4 and Alternative 4A. As described for Alternative 4, phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under Alternative 4A, relative to Existing Conditions or the No Action Alternative (ELT), upstream of the Delta. Phosphorus concentrations may increase during January through March at locations in the Delta where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. However, based on the DSM2 fingerprinting results (Figures 309 through 330 in Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations (in Figure 8-56), the magnitude of increases during these months is expected to be negligible to low (i.e., <0.02 mg/L) at all Delta locations relative to Existing Conditions and the No Action Alternative (ELT). Thus, phosphorus concentrations in the Delta and waters exported from Banks and Jones pumping plants to the SWP/CVP Export Service Areas are expected to be similar to Existing Conditions and the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on phosphorus in the LLT are expected to be similar to those described above.

NEPA Effects: In summary, operation of the water conveyance facilities would have little to no effect on phosphorus concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas, relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on phosphorus are considered to be not adverse.

***CEQA Conclusion*:** The effects of Alternative 4A on phosphorus levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the Alternative 4. There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 4A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

As described for Alternative 4 (see Section 8.3.3.9) Environmental Commitments 3, 4, and 6–11 would include activities that create additional aquatic habitat, which may affect phosphorus dynamics and speciation in localized areas where the restoration would occur, but would not contribute to additional phosphorus loading. Therefore, phosphorus concentrations are not expected to change substantially in the affected environment as a result of these restoration activities. Unlike under Alternative 4, *CM19 Urban Stormwater Treatment* would not be implemented under Alternative 4A. Because urban stormwater is a potential source of phosphorus in the affected environment, the slight decreases in phosphorus loading expected to occur as a result of implementation of CM19 under Alternative 4, relative to Existing Conditions and the No Action Alternative, would not occur under Alternative 4A. Environmental Commitments 12, 15, and 16 do not include actions that would affect phosphorus sources or loading.

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, relative to the No Action Alternative (ELT and LLT), the effects on phosphorus from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the SWP/CVP Export Service Areas due to implementation of these Environmental Commitments relative to Existing Conditions. Because phosphorus concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and, thus, the Environmental Commitments would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, any increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 4A on selenium concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9), because factors affecting selenium concentrations in these water bodies would be similar. Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions or the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta. Similarly, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under Alternative 4A, given the relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Alternative 4A would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative (ELT) at all modeled Delta assessment locations (Appendix 8M, *Selenium,* Table M-33). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.03 μg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (3% or less) in long-term average available assimilative capacity for selenium, relative to USEPA's draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-44). The long-term average selenium concentrations in water under Alternative 4A (range 0.09–0.40 μg/L) would be similar to Existing Conditions (range 0.09–0.41 μg/L) and the No Action Alternative (ELT) (range 0.09–0.39 μg/L), and would be below the draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 4A would result in small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Appendix 8M, *Selenium,* Tables M-34, and M-38). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0, indicating low probability of adverse effects. Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 15% relative to Existing Conditions and to the No Action Alternative (ELT) in all years (from about 4.7 to about 5.4 mg/kg dry weight), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 9–12% in all years (from about 4.4 to 4.9 mg/kg dry weight) (Appendix 8M, *Selenium,* Tables M-41 and M-42). Selenium concentrations in sturgeon during drought years are expected to increase by about 27% at those locations (Appendix 8M, Tables M-41 and M-42). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative (ELT) and for all years in the San Joaquin River at Antioch (where quotient increases from 0.94 to 1.1) (Appendix 8M, Table M-43). The High Toxicity Threshold Quotient would be less than 1.0 at both locations for all years and drought years (Appendix 8M, Table M-43).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in Appendix 8M, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium. Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Residence time of water in the Delta is expected to increase relative to Existing Conditions primarily as a result of habitat restoration (8,000 acres of tidal habitat restoration and enhancements to the Yolo Bypass) that is assumed to occur under the No Action Alternative (ELT) separate from Alternative 4A. The changes in flow paths of water through the Delta and change in operation of the south Delta pumps that would occur due to facilities operations and maintenance of Alternative 4A could result in localized increases in residence time in various Delta sub-regions and decreases in residence time in other areas. Residence times during July through November was modeled for the Biological Assessment for the California WaterFix (ICF International 2016). The Proposed Action modeled in the Biological Assessment is Alternative 4A. Residence time tables for the lower Sacramento River and lower San Joaquin River show slight increases in residence time (in days) in the summer months and slight decreases in the fall months (ICF International 2016: Tables 6.1-32 and 6.1-33).

If increases in fish tissue or bird egg selenium were to occur as a result of increased residence time, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. Thus, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time would be a concern is the western Delta and Suisun Bay for sturgeon. Based on the expected minor increases in residence time in the western Delta, any increases are not expected to be of sufficient magnitude to substantially affect selenium bioaccumulation.

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 4A would result in essentially no change in selenium concentrations throughout the Delta for most biota (about 1% or less), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative

4A would not be expected to substantially increase the frequency with which the applicable water quality criterion or toxicity and level of concern benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or to substantially degrade the quality of water in the Delta, with regard to selenium. These changes would be similar to those described for Alternative 4.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Alternative 4A would result in small (0.04–0.09 µg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative (ELT), for the entire period modeled (Appendix 8M, *Selenium,* Table M-33). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants, relative to the USEPA's draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-44). The long-term average selenium concentrations in water for Alternative 4A (range 0.16–0.20 µg/L) would be well below the draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 4A would result in small changes (about 1% or less) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, *Selenium,* TableM-38). Concentrations in biota would not exceed any selenium toxicity or level of concern benchmarks for Alternative 4A.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

NEPA Effects: Relative to the No Action Alternative (ELT and LLT), Alternative 4A would result in essentially negligible changes in selenium concentrations in water upstream of the Delta. Similarly, there would be negligible changes in selenium water and most biota concentrations in the Delta, with no exceedances of benchmarks for biological effects. For sturgeon in the Delta, there would be only a small increase of threshold exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark. At the Banks and Jones pumping plants, Alternative 4A would cause no increases in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations. Therefore, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 4A are considered to be not adverse.

CEQA Conclusion: There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources

Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate Alternative 4A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.1 for Alternative 4A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 4A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 4A would cause no increases in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 4A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under Alternative 4A would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

As described for Alternative 4 (see Section 8.3.3.9) Environmental Commitments 12, 15, and 16 do not involve actions that would increase selenium loading or otherwise alter selenium concentrations or residence time such that there would be a change in selenium concentrations in water or biota.

Further, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, Environmental Commitments 3, 4, and 6–11 would not substantially increase selenium concentrations in the water bodies of the affected environment.

While the implementation of Environmental Commitment 4 would create shallow backwater areas that could result in local increased water residence times, the extent of these areas would be minimal relative to the area of the Delta, and environmental changes associated with their development are unlikely to be of magnitude that would measurably change selenium concentrations in water or biota, relative to Existing Conditions. Further, although water residence times associated restoration could increase, they are not expected to increase without bound, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed water system. However, because increases in bioavailable selenium in habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments, AMMs, and CMs*, for a description of the environmental commitment project proponents are making with respect to selenium management; and BDCP Appendix 3.C, *Avoidance and Minimization Measures*, for additional detail on this avoidance and minimization measure (AMM27).

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to the No Action Alternative (ELT and LLT). Therefore, the effects on selenium from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to Existing Conditions. Therefore, it is expected that with implementation of these Environmental Commitments there would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the SWP/CVP Export Service Areas, relative to Existing Conditions. As such, these Environmental Commitments would not cause additional exceedances of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Given the factors discussed in the assessment above and for Alternative 4 (see Section 8.3.3.9), any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, these Environmental Commitments would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a CWA Section 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see BDCP Appendix 3.C, *Avoidance and Minimization Measures*, for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 4A on trace metal concentrations in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta.

In the Delta, for metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, and very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based (see Tables 8-51 and 8-52 in Section 8.3.1.7, *Constituent-Specific Considerations Used in the Assessment)*. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur. For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar (see Tables 8–10 in Appendix 8N,*Trace Metals*) and average concentrations are below human health criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur.

Because Alternative 4A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP Export Service Areas, relative to Existing Conditions or the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on trace metals in the LLT are expected to be similar to those described above.

As such, Alternative 4A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: Alternative 4A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals, relative to the No Action Alternative (ELT and LLT). Therefore, the effects on trace metals from implementing Alternative 4A are determined to not be adverse.

CEQA Conclusion: While Alternative 4A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, this would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under Alternative 4A.

Because Alternative 4A is not expected to result in substantial changes in trace metal concentrations in Delta waters, which includes Banks and Jones pumping plants, effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas. CM19, which under Alternative 4 would fund projects to contribute to reducing pollutant discharges in urban stormwater, would not be implemented under Alternative 4A, thus the associated trace metal reduction described for Alternative 4 would not occur under this alternative. However, stormwater discharges would continue to be regulated by the state and contributions would be expected to be similar to Existing Conditions and the No Action Alternative (ELT and LLT). The remaining Environmental Commitments would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these Environmental Commitments would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

NEPA Effects: Because Environmental Commitments 3, 4, 6–12, 15, and 16 present no new sources of trace metals to the affected environment, the effects on trace metal concentrations from implementing these Environmental Commitments are determined to be not adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas, because they present no new sources of trace metals to the affected environment. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

As described for Alternative 4 (see Section 8.3.3.9), the operation of the water conveyance facilities under Alternative 4A is expected to have a minimal effect on TSS and turbidity levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions and the No Action Alternative (ELT and LLT). This is because the factors that would affect TSS and turbidity levels in the surface waters of these areas would be the same. TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water. Within the Delta, TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of inflows (and associated sediment load), as well as fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water. These factors would be similar under Alternative 4A and Alternative 4, are expected to be minimally different from Existing Conditions and the No Action Alternative (ELT and LLT). Because Alternative 4A is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative (ELT and LLT), Alternative 4A also is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

NEPA Effects: Because TSS concentrations and turbidity levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on TSS and turbidity from implementing Alternative 4A are determined to not be adverse.

CEQA Conclusion: As described for Alternative 4 (see Section 8.3.3.9) changes in river flow rate and reservoir storage that would occur under Alternative 4A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 4A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. Creation of habitat and open water through implementation of these Environmental Commitments could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels, though the geographic extent of the effects would be substantially less than under Alternative 4, because less land would be converted under Alternative 4A. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under Existing Conditions or the No Action Alternative (ELT and LLT).

CM19, which under Alternative 4 would fund projects to contribute to reducing pollutant discharges in stormwater, would not be implemented under Alternative 4A, thus the associated TSS and turbidity reduction described for Alternative 4 would not occur under this alternative. Nevertheless, stormwater discharges would still be subject to the state's NPDES program requirements to implement control measures, which would contribute to controlling TSS and turbidity in discharges.

The remaining Environmental Commitments would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

***NEPA Effects*:** Localized, temporary changes in TSS and turbidity could occur associated with the restoration actions of Environmental Commitments 3, 4, 6–12, 15, and 16. However, these changes would be gradual and not expected to substantially differ from No Action Alternative (ELT and LLT) conditions. Therefore, the effects on TSS and turbidity from implementing these Environmental Commitments are determined to be not adverse.

***CEQA Conclusion*:** It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities for the Water Conveyance Facilities and Environmental Commitments

The potential construction-related water quality effects that would occur under Alternative 4A would be of a lower magnitude compared to the effects described for Alternative 4 (see Section 8.3.3.9). This is because the size and number of construction activities for some Environmental Commitments under Alternative 4A would be reduced, or not occur, compared to Alternative 4. The construction-related activities for the water conveyance facilities under Alternative 4A would be the same as described for Alternative 4. However, there would be substantially less area of in-water habitat restoration activities implemented under Alternative 4A compared to Alternative 4. Therefore, the amount of construction activity under Alternative 4A would be lower than described for Alternative 4, thus resulting in less potential for construction-related disturbances and contaminant discharges to surface waters.

The construction-related activities for Alternative 4A would be most extensive for the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, RTM dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the Byron Tract Forebay, canal and gates between the Byron Tract Forebay tunnel shafts and the approach canal to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly four years to complete.

Habitat restoration Environmental Commitments in the Delta, including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, also would involve substantial in-water construction-related activities in localized areas of the Delta. Other non-habitat restoration Environmental Commitments are not anticipated to involve construction activities that would result in substantial discharges of any constituents of concern.

NEPA Effects: Potential construction-related water quality effects may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.
- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce DO levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.
- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.
- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, and dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury).However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. This alternative would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

Construction-related activities would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). The General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required PRDs that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains NALs and for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*), for which Appendix 3B identifies specific BMPs within these categories:

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.
- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.
- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.
- Construction Site Dewatering and Pipeline Testing (BMP category A.8).Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.
- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category "A" BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments, AMMs, and CNs*), BMPs implemented also would include the Category "B" BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category "C" BMPs (In-Water Construction BMPs) and Category "D" BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category "E" BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific environmental commitments, which may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from this alternative would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, with respect to the No Action Alternative conditions, this alternative would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: As explained above, water quality effects resulting from construction-related activities would be less under Alternative 4A compared to Alternative 4, which was determined to be less than significant. Moreover, because environmental commitments would be implemented under Alternative 4A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or CWA Section 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause CWA Section 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Adverse effects from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under Alternative 4A or the No Action Alternative (ELT and LLT). Consequently, any modified reservoir operations under Alternative 4A are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT).

Delta

During the June through October period when *Microcystis* blooms occur in the Delta, it is a combination of flows, associated residence time, and water temperatures that are believed to most influence *Microcystis* bloom formation.

Since Delta water temperatures are largely driven by air temperature, climate change that increases air temperatures relative to Existing Conditions would be expected to increase ambient water temperatures in the Delta by 1.3–2.5°F. These climate changes in the ELT are expected to occur in the Delta under the No Action Alternative, relative to Existing Conditions. Alternative 4A operations and maintenance is not expected to cause increased Delta water temperatures, relative to Existing Conditions or the No Action Alternative.

Under Alternative 4A, a portion of the Sacramento River water which is conveyed through the Delta to the south Delta intakes under Existing Conditions would be replaced at various locations throughout the Delta by other source water due to diversion of Sacramento River water at the north Delta intakes. To determine how hydrologic effects of Alternative 4A, relative to Delta hydrology under the No Action Alternative (ELT), may affect *Microcystis* occurrence and bloom formation, flows, residence time, and peak daily channel velocity were analyzed for various Delta locations.

Frequency of given flows were assessed in the Biological Assessment for the California WaterFix (ICF International 2016) using flow in the San Joaquin River past Jersey Point and flow in the Sacramento River at Rio Vista. The San Joaquin River analysis found that flow conditions conducive to *Microcystis* blooms in the San Joaquin River would occur less frequently under the Proposed Action, which is Alternative 4A, compared to the No Action Alternative. Based on flow analysis in the Sacramento River, there could be a decrease in flows at Rio Vista compared to the No Action Alternative. Because turbid conditions and sufficient flow to create channel turbulence are the norm here, and are expected to remain consistent with Existing Conditions in the future, it is expected that current conditions will continue and that *Microcystis* blooms will not increase here (ICF International 2016).

Based on *Microcystis* life history strategy to outcompete other algal species and the inhibitory effect of flow and turbulence on its ability to do so, maximum daily channel velocities (which creates channel turbidity and turbulence) also were assessed using DSM2 velocity output for a number of locations throughout the Delta (Appendix 8P). The evaluation of flow velocities shows little to no effects on peak daily velocities under Alternative 4A compared to the No Action Alternative at each location assessed. This indicates that areas of the Delta that are currently turbid will remain turbid and vertical mixing of the water column will be similar under Alternative 4A and the No Action Alternative. As stated in Section 8.3.1.7, *Microcystis* cannot effectively retain its buoyancy or outcompete other faster growing phytoplankton in turbid, turbulent waters. Therefore, based on Alternative 4A maintaining similar to equivalent peak daily flow velocities in Delta channels (and turbidity and turbulence conditions), Alternative 4A would not be expected to substantially increase the frequency or geographic extent of Microcystis blooms in the Delta, relative to what would occur under the No Action Alternative.

Changes in flow paths of water through the Delta and change in operation of the south Delta pumps that would occur due to facilities operations and maintenance of Alternative 4A could result in localized increases in residence time in various Delta sub-regions and decreases in residence time in other areas. In addition to the effects of operations and maintenance of Alternative 4A, increases in water residence times are expected occur due to separate factors and actions concurrent with the alternative, including habitat restoration (8,000 acres of tidal habitat and enhancements in the Yolo Bypass) and sea level rise due to climate change.

Residence times in 19 Delta sub-regions during the *Microcystis* bloom season of July through October was modeled for the Biological Assessment for the California WaterFix (ICF International 2016). The Proposed Action modeled in the Biological Assessment is Alternative 4A. Modeling results show varying levels of change in residence time, depending on sub-region, month and water year type (Tables 6.6-5 through 6.6-25, ICF International 2016). DSM2 PTM output indicates residence times may increase in parts of the southern and central Delta. Because there is no published analysis of the relationship between *Microcystis* occurrence and residence time, there is uncertainty on how increased residence times may affect *Microcystis* occurrences (ICF International 2016). In some areas of the Delta currently affected by *Microcystis* blooms, decreasing median residence times in some months (decreases from 0.1 – 3.8 days) has potential to lower the magnitude and duration of *Microcystis* blooms. However, in other areas of the Delta that experience *Microcystis* blooms, longer median residence times in some months (0.1 - 16.5 days) has potential to increase the magnitude and duration of *Microcystis* blooms.

The changes in residence time are driven by a number of factors accounted for in the modeling, including diversion of Sacramento River water at the proposed north Delta intake facilities, which does not account for the flexibility of operations of the north and south Delta intakes or real-time management of reservoir releases. To ensure project operations do not create increased *Microcystis* blooms in the Delta, water flow through Delta channels would be managed through real-time operations, particularly the balancing of the north and south Delta diversions. By operating the south Delta pumps more frequently during periods conducive to increased *Microcystis* blooms, residence times would be substantially reduced from those modeled for Alternative 4A. Reducing residence times would decrease the potential for blooms to develop, and thus decrease potential microcystin increases due to project operations. As such, effects of Alternative 4A on *Microcystis* levels, and thus microcystin concentrations in the Delta, would not be made more adverse relative to Existing Conditions and the No Action Alternative (ELT and LLT).

In summary, operations and maintenance of Alt 4A is not expected to result in flow or velocity changes in the Delta that would cause substantial increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, relative to Existing Conditions or the No Action Alternative. In some areas of the Delta that experience *Microcystis* blooms, longer median residence times in some months has potential to increase the magnitude and duration of *Microcystis* blooms. However, factors that control *Microcystis* blooms in the Delta are still under study, so there is some uncertainty regarding this impact finding. *Microcystis* blooms may also occur more frequently in the Delta in the future, relative to Existing Conditions, due to factors unrelated to the project alternative, including: 1) increased residence times resulting from restoration activities and climate change-related sea level rise and 2) climate change-related increased Delta water temperatures. To ensure project operations under Alternative 4A do not create significant increases in *Microcystis* blooms in the Delta, that may be associated with increased residence times, water flow through Delta channels would be managed through real-time operations.

SWP/CVP Export Service Area

As described above for the Delta, source waters to the south Delta intakes could be adversely affected, relative to Existing Conditions, by *Microcystis* both from an increase in Delta water temperatures associated with climate change and from an increase in water residence times. The impacts from increased Delta water residence times would be primarily related to habitat restoration (8,000 acres of tidal habitat restoration and enhancements in the Yolo Bypass) that is assumed to occur separate from Alternative 4A. The combined effect of these factors on the potential for *Microcystis* blooms in source waters to the south Delta intakes is expected to be much greater than the influence of operations and maintenance of Alternative 4A, the effects of which will be mitigated through real time operations. Increases in ambient air temperatures due to climate change relative to Existing Conditions are expected under this alternative. Increases in ambient air temperatures are expected to result in warmer ambient water temperatures, and thus conditions more suitable to *Microcystis* growth, in the water bodies of the SWP/CVP Export Service Areas. The incremental increase in long-term average air temperatures would be less at the ELT (2.0°F), compared to the LLT (4.0°F).

As discussed in the Delta section above, Alternative 4A facilities operations and maintenance is not expected to substantially adversely affect *Microcystis* blooms, relative to Existing Conditions and the No Action Alternative (ELT and LLT). Additionally, residence time and water temperature conditions in the SWP/CVP Export Service Areas are not expected to become more conducive to *Microcystis* bloom formation due to the operations and maintenance of Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), because water residence times are not projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change and not due to Alternative 4A.

NEPA Effects: Modified reservoir operations under Alternative 4A are not expected to promote *Microcystis* production upstream of the Delta, relative to the No Action Alternative (ELT and LLT). Similarly, operations and maintenance of Alternative 4A are not expected to substantially increase water residence times or ambient water temperatures in the Delta, including at the Banks and Jones pumping plants, and thus is not expected to result in adverse effects on *Microcystis* in the Delta, relative to No Action Alternative (ELT and LLT). Lack of adverse effects on *Microcystis* in the Delta would mean that Delta waters diverted into the SWP/CVP Export Service Areas would not be adversely affected. Finally, the potential for *Microcystis* bloom formation within the SWP/CVP Export Service Area water bodies and canals would not be expected to change substantially, if at all, because water residence times are not projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change and not due to Alternative 4A. Thus, the effects on *Microcystis* in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas from implementing Alternative 4A are determined to be not adverse.

CEQA Conclusion: Modified reservoir operations under Alternative 4A are not expected to promote *Microcystis* production upstream of the Delta, relative to the Existing Conditions. Increased frequency and magnitude of *Microcystis* blooms may occur in the Delta in the future, relative to Existing Conditions, due to increased residence times resulting from restoration activities unrelated to the project alternative, as well as climate change and sea level rise that are expected to increase Delta water temperatures. Such increases in residence time and water temperatures would not be caused by implementation of Alternative 4A. Operations and maintenance of Alternative 4A, including the use of real-time operations, are not expected to result in flow and temperature conditions in the Delta, including at the Banks and Jones pumping plants, that would cause substantial increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas of the Delta would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Microcystin, the toxin produced by *Microcystis,* is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences due to climate change and sea level rise may lead to increased microcystin presence in the Delta, relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation related to microcystin levels may occur and, thus, impacts on beneficial uses could occur, these impacts are not related to implementation of Alternative 4A. Although there is uncertainty regarding this impact, the effects on *Microcystis* from implementing water conveyance facilities are determined to be less than significant. No mitigation is required.

Impact WQ-33: Effects on *Microcystis* Bloom Formation Resulting from Environmental Commitments

Under Alternative 4A, fisheries enhancements to the Yolo Bypass would not be implemented, but under a plan separate and distinct from Alternative 4A, enhancements to the Yolo Bypass and 8,000 acres of tidal habitat restoration would be implemented in the ELT. The Yolo Bypass enhancements are assumed to occur under the No Action Alternative, as well as 8,000 acres of tidal habitat restoration. These activities would create shallow backwater areas that could result in local warmer water and increased water residence time of magnitude and extent that could result in measurable changes on *Microcystis* levels in the Delta, relative to Existing Conditions. However, the area of tidal habitat restoration to be implemented as a component of Alternative 4A, relative to the No Action Alternative, is so small that it would have negligible effects compared to the development of 8,000 acres of tidal habitat that would be developed independent of Alternative 4A. Thus, compared to the No Action Alternative, which isolates the effects of Alternative 4A habitat actions, Alternative 4A

Environmental Commitments are not expected to contribute to measurable changes on *Microcystsis* levels in the Delta.

NEPA Effects: Based on the discussion above, the effects on *Microcystis* from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusions: Based on the discussion above, Environmental Commitments 3, 4, 6–12, 15, and 16 would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta would occur at the early long-term for reasons unassociated with implementation of the Environmental Commitments, including tidal habitat restoration. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in Microcystis occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation related to microcystins levels may occur and, thus, significant impacts on beneficial uses could occur, these impacts are not related to implementation of the Environmental Commitments. Therefore, the effects on *Microcystis* from implementing the Environmental Commitments are determined to be less than significant. No mitigation is required.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance and Environmental Commitments

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 4A would have a less-than-significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Bromide
- Chloride
- DOC
- DO
- Pathogens
- Pesticides
- Trace metals
- Turbidity and TSS
- *Microcystis*

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. Chloride, DOC, and bromide concentrations also are of concern in drinking water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses.

Changes in Delta DO, pathogens, pesticides, trace metals, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Changes in *Microcystis* would be primarily due to factors unassociated with the project alternative. Thus, changes in boron, bromide, chloride, DOC, DO, pathogens, pesticides, trace metals, turbidity and TSS, and *Microcystis* in Delta outflow associated with implementation of Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT) are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay, as described for Alternative 4 (see Section 8.3.3.9).

Elevated EC is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. San Francisco Bay does not have an AGR beneficial use designation. As described for Alternative 4, salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. However, the changes in Delta outflow due to Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Also, as described for Alternative 4, changes in nutrient loading would not be expected to contribute to adverse effects to beneficial uses. Changes in nitrogen (ammonia and nitrate) loading to Suisun and San Pablo Bays under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay. The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. As described for Alternative 4, any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary. Therefore, changes in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay, relative to Existing Conditions and the No Action Alternative (ELT and LLT), shown in Appendix 8O, *San Francisco Bay Analysis*, Table 8O-1, are not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Similar to Alternative 4, loads of mercury and methylmercury, from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT and LLT) (Appendix 8O, *San Francisco Bay Analysis*, Table 8O-2). Also, the incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 μg/L) under this alternative (Appendix 8O, Table 8O-3).

NEPA Effects: Based on the discussion above, Alternative 4A, relative to the No Action Alternative (ELT and LLT), would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, turbidity and TSS, or *Microcystis* in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, effects on the San Francisco Bay from implementation of water conveyance facilities and Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: As with Alternative 4, Alternative 4A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals, turbidity or TSS, and *Microcystis* are anticipated in the Delta due to the implementation of Alternative 4A, relative to Existing Conditions, therefore, no substantial changes to these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow and thus, have minimal influence on salinity changes. Changes in nutrient load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. As with Alternative 4, the change in mercury and methylmercury load (which is based on source water and Delta outflow), relative to Existing Conditions, would be within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Similarly, based on Alternative 4 estimates, the increase in selenium load would be minimal, and total and dissolved selenium concentrations would be expected to be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the change in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

8.3.4.3 Alternative 2D—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 1, 2, 3, 4 and 5 (15,000 cfs; Operational Scenario B)

Discussion of water quality impacts of Alternative 2D was first provided in the RDEIR/SDEIS. The water quality assessments in the RDEIR/SDEIS for boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Services Areas utilized results from water quality modeling performed for Alternative 2A in the ELT, which included Yolo Bypass improvements, 25,000 acres of tidal habitat restoration, and the EC compliance location at Emmaton relocated to Threemile Slough. The analysis of effects of Alternative 2D, presented herein, on boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Service Areas is based on revised modeling, which assumed implementation of Yolo Bypass improvements, the EC compliance location remaining at Emmaton, and no tidal habitat restoration. Because the modeling of Alternative 2D and the No Action Alternative (ELT) included Yolo Bypass Improvements, but no tidal habitat restoration, comparison of modeling results for Alternative 2D to No Action Alternative (ELT) results in the impact discussions below allows for isolating and identifying effects solely due to implementation of Alternative 2D in the ELT.

As described in Chapter 3, *Description of Alternatives*, actions associated with Alternative 4 that are not proposed to be implemented under Alternative 2D would continue to be pursued as part of existing, but separate, projects and programs associated with the 2008 USFWS and 2009 NMFS BiOps, California EcoRestore, and the 2014 California Water Action Plan. Due to the reduced suite of Environmental Commitments in Alternative 2D compared to Alternative 4 (in particular, significantly less tidal habitat restoration), the impacts to water quality due to Alternative 2D are substantially less compared to Alternative 4, particularly in the Delta.

The water quality impact conclusions for Alternative 2D remain the same as those presented in the RDEIR/SDEIS. The revisions to the assessment are in the presentation of modeled changes in concentrations, water quality criteria/objective exceedances, and use of assimilative capacity, and refinements to mitigation measures for EC.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), substantial point and non-point sources of ammonia-N do not exist upstream of the SRWTP at Freeport in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Thus, like Alternative 4, operation of the water conveyance facilities under Alternative 2D would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT and LLT). Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As described for Alternative 4 (see Section 8.3.3.9), a substantial decrease in Sacramento River ammonia concentrations is expected under Alternative 2D relative to Existing Conditions, due to planned lowering of ammonia in the SRWTP effluent discharge, and this is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Concentrations of ammonia at locations not influenced notably by Sacramento River water would change little relative to Existing Conditions, due to the similarity in San Joaquin River and San Francisco Bay concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 2D would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Relative to the No Action Alternative (ELT and LLT), the primary mechanism that could potentially alter ammonia concentrations under Alternative 2D is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This flow change would be attributable only to operations of the water conveyance facilities, since the same assumptions regarding SRWTP discharge ammonia concentrations, water demands, climate change, and sea level rise apply to both Alternative 2D and the No Action Alternative (ELT and LLT). A simple mass balance calculation was performed to calculate ammonia concentrations downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 2D and the No Action Alternative (ELT) to assess the effects of the flow changes. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia limitations (1.5 mg/L-N in Apr–Oct, 2.4 mg/L-N in Nov–Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-74 shows monthly average and long-term annual average predicted concentrations under Alternative 2D. As Table 8-74 shows, average monthly ammonia concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 2D and the No Action Alternative (ELT) are expected to be similar. In comparison to the No Action Alternative (ELT), minor increases in monthly average ammonia concentrations would occur during July through September, and November under Alternative 2D. Minor decreases in ammonia concentrations are expected for Alternative 2D in January through June, and October and December. The annual average concentration under Alternative 2D would be the same as that under the No Action Alternative (ELT). Relative to the No Action Alternative (LLT), Alternative 2D (LLT) is expected to result in similar minor increases in Sacramento River ammonia concentration, because the increased water demands, climate change, and sea level rise in the LLT would occur under both alternatives, and neither would affect ammonia sources or loading. The estimated concentrations in the Sacramento River downstream of Freeport under Alternative 2D would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 2D, relative to the No Action Alternative (ELT and LLT), are not expected to substantially increase ammonia concentrations at any Delta locations.

Ammonia concentrations downstream of Freeport in the Sacramento River under Alternative 2D would be similar to those under Alternative 4 (see Table 8-67 in Section 8.3.3.9). As stated for Alternative 4, any negligible increases in ammonia concentrations that could occur at certain locations in the Delta under Alternative 2D would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to ammonia.

Table 8-74. Estimated Ammonia (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative Early Long-Term (ELT) and Alternative 2D

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative (ELT)	0.076	0.082	0.069	0.062	0.059	0.062	0.059	0.062	0.067	0.060	0.067	0.064	0.066
Alternative 2D ELT	0.075	0.086	0.068	0.061	0.058	0.061	0.058	0.061	0.062	0.062	0.070	0.067	0.066

SWP CVP Export Service Areas

As discussed above, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 2D, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). Like Alternative 4, this decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regard to ammonia. Furthermore, as discussed above, for all areas of the Delta, including Banks and Jones pumping plants, ammonia concentrations are not expected to be substantially different under Alternative 2D (ELT) relative to the No Action Alternative (ELT), and Alternative 2D (LLT) relative to the No Action Alternative (LLT). Thus, any negligible increases in ammonia concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade water quality at these locations, with regard to ammonia.

NEPA Effects: In summary, ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas are not expected to be substantially different under Alternative 2D relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on ammonia are considered to be not adverse.

CEQA Conclusion: The magnitude and direction of changes in ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas would be approximately the same as expected under Alternative 4, relative to Existing Conditions. There would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 2D relative to Existing Conditions. As such, Alternative 2D is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect ammonia sources or loading. Based on these findings, the effects on ammonia from the implementation Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D are determined to not be adverse.

***CEQA Conclusion*:** Land use changes that would occur from the Environmental Commitments are not expected to contribute substantially increase ammonia concentrations, because the amount of area to be converted would be small relative to existing habitat, and any resulting ammonia would likely be rapidly converted to nitrate. Thus, there would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. As such, implementation of these Environmental Commitments would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these Environmental Commitments, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 2D there would be no expected change to the sources of boron in the Sacramento River and eastside tributary watersheds and, thus, resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease by 1%, relative to Existing Conditions (in association with the different operational components of Alternative 2D in the ELT, climate change, and increased water demands) (Appendix 8F, *Boron*, Table Bo-32). The reduced flow relative to Existing Conditions would result in possible increases in long-term average boron concentrations of up to about 0.5% relative to the Existing Conditions. Flows would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial boron increases relative to the No Action Alternative (ELT). The increased boron concentrations, relative to Existing Conditions, under Alternative 2D in the ELT would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 2D in the ELT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 2D in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect boron sources in these areas.

Delta

Effects of water conveyance facilities on boron under Alternative 2D in the Delta would be similar to the effects discussed for Alternative 4.

The effects of Alternative 2D relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action Alternative (ELT), Alternative 2D would result in increased long-term average boron concentrations for the 16-year period modeled at most of the interior Delta locations (increases up to 3% at the S. Fork Mokelumne River at Staten Island, 10% at Franks Tract, and 13% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-28). The long-term average boron concentrations at most of the western Delta assessment locations would not change measurably. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or the 500 µg/L agricultural objective at the majority of assessment locations, which represents no change from the Existing Conditions and No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-3C). A small increase in the frequency of exceedances 500 µg/L agricultural objective at the Sacramento River at Mallard Island (i.e., as much as 3% in the drought period relative to the No Action Alternative [ELT]) would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. Minor reductions in long-term average assimilative capacity of up to 8% at interior Delta locations (i.e., Old River at Rock Slough) would occur with respect to the 500 µg/L agricultural objective (Appendix 8F, *Boron*, Table Bo-29). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 2D, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, *Boron*, Figure Bo-6).

Effects of Alternative 2D in the Delta in the LLT, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to those described above for the ELT. Boron concentrations may be higher at western Delta locations due to greater effects of climate change on sea level rise that would occur in the LLT; however, these effects are independent of the alternative. Further, boron is of concern in waters diverted for agricultural use, which primarily occurs in the interior Delta, and based on Delta source water characteristics (see Table 8-42 in Section 8.3.1.7, *Construction-Specific Considerations Used in the Assessment*), boron concentrations in the interior Delta would be expected to remain suitable for agricultural use.

SWP/CVP Export Service Areas

Under the Alternative 2D, long-term average boron concentrations would decrease at the Banks pumping plant (24%) and at Jones pumping plant (28%) relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-28) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing CWA Section 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading. These same effects on boron at the Banks and Jones pumping plants would be expected in the LLT, because the primary effect of climate change on sea level rise and boron concentrations is expected in the western Delta.

Maintenance of SWP and CVP facilities under Alternative 2D would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative (ELT and LLT), Alternative 2D would result in relatively small increases in long-term average boron concentrations in the Delta, not measurably increase boron levels in the lower San Joaquin River, and reduce boron levels in water exported to the SWP/CVP export service areas. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Based on the above assessment, any modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels upstream of the Delta. Small increases in boron levels predicted for interior Delta locations in response to a shift in the Delta source water percentages would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 2D maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2D would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 2D would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 2D would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing CWA Section 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

Effects on boron from implementation of Environmental Commitments under Alternative 2D would be the same as those described for Alternative 4A.

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 2D present no new direct sources of boron to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. Habitat restoration activities in the Delta, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative (ELT and LLT). Consequently, as they pertain to boron, implementation of the Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 2D would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. As such, their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 2D in the ELT there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Thus, changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial bromide increases (Appendix 8E, *Bromide*, Table 24). Moreover, there are no existing municipal intakes on the lower San Joaquin River, which is the beneficial use most sensitive to elevated bromide concentrations. Consequently, Alternative 2D in the ELT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the San Joaquin River, the eastside tributaries, or their associated reservoirs upstream of the Delta due to changes in bromide concentrations.

Effects of Alternative 2D in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect bromide sources in these areas.

Delta

Estimates of bromide concentrations at Delta assessment locations were generated using a mass balance approach, and using relationships between EC and chloride and between chloride and bromide and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in bromide at Delta assessment locations based on both approaches.

Based on the mass balance modeling approach for bromide, relative to Existing Conditions, Alternative 2D long-term average bromide concentrations would increase in the S. Fork Mokelumne River at Staten Island, and decrease at all other assessment locations (Appendix 8E, *Bromide*, Table 22). Average bromide concentrations at Staten Island would increase from 50 µg/L under Existing Conditions to 55 µg/L (10% increase) for the modeled 16-year hydrologic period (1976–1991). However, multiple interior and western Delta assessment locations would have an increased frequency of exceedance of 50 µg/L, which is the CALFED Drinking Water Program goal for bromide as a long-term average applied to drinking water intakes (Appendix 8E, Table 22). These locations are the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. The greatest increase in frequency of exceedance of the CALFED Drinking Water Program long-term goal of 50 µg/L would occur in the S. Fork Mokelumne River (12% increase) and Sacramento River at Emmaton (5% increase). The increase in frequency of exceedance of the 50 µg/L threshold at the other locations would be 2% or less. Similarly, these locations and North Bay Aqueduct at Barker Slough would have an increased frequency of exceedance of 100 µg/L, which is the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts (Appendix 8E, Table 22). The greatest increase in frequency of exceedance of 100 µg/L would occur at Franks Tract (6% increase). The increase in frequency of exceedance of the 100 µg/L threshold at the other locations would be 5% or less.

Changes in long-term average bromide concentrations and changes in threshold exceedance frequencies relative to the No Action Alternative (ELT) are generally of similar magnitude to those previously described relative to Existing Conditions (Appendix 8E, *Bromide*, Table 22). However, unlike the Existing Conditions comparison, relative to the No Action Alternative (ELT), long-term average bromide concentrations in the San Joaquin River at Buckley Cove and the North Bay Aqueduct at Barker Slough would increase under Alternative 2D, although the increases would be relatively small (<2%). Further, at the North Bay Aqueduct, the frequency of exceedance of the 50 µg/L would increase from 35% to 40% and the frequency of exceedance of the 100 µg/L threshold would increase from 0% to 1%. Also, there would not be an increased exceedance of the 100 µg/L threshold at Emmaton and Rock Slough.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide were consistent with the discussion above, and assessment of bromide using these modeling results lead to the same conclusions as are presented above for the mass balance approach (Appendix 8E, *Bromide*, Table 23).

The magnitude of bromide concentration increases at Mallard Slough and in the San Joaquin River at Antioch during their historical months of use, relative to Existing Conditions and the No Action Alternative (ELT), would be generally similar to or less than those described for Alternative 4 (Appendix 8E, *Bromide*, Table 25), and the frequency of exceedance of bromide thresholds would be similar (Appendix 8E, Table 22). As described for Alternative 4, the use of seasonal intakes at these locations is largely driven by acceptable water quality, and thus has historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at Antioch and Mallard Slough would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The effects of Alternative 2D in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above. There may be higher bromide concentrations in the LLT in the western Delta, but this would be associated with sea level rise, not the project alternative, because the primary source of bromide to the Delta is sea water intrusion.

SWP/CVP Export Service Areas

Under Alternative 2D, long-term average bromide concentrations at the Banks and Jones pumping plants, based on the mass balance modeling approach, would decrease. Long-term average bromide concentrations for the modeled 16-year hydrologic period at the pumping plants would decrease by as much as 50% relative to Existing Conditions and 47% relative to the No Action Alternative (ELT) (Appendix 8E, *Bromide*, Table 22). As a result, less frequent exceedances of the 50 μg/L and 100 μg/L assessment thresholds would occur and an overall improvement in SWP/CVP Export Service Areas water quality would occur respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also occur since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide are consistent with the mass balance results, and assessment of bromide using these modeling results leads to the same conclusions (Appendix 8E, Table 23).

The effects of Alternative 2D in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above, because the sea level rise that could occur in the LLT would not be expected to result in substantial bromide contributions to the water exported at Banks and Jones pumping plants.

Maintenance of SWP and CVP facilities under Alternative 2D would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, the operations and maintenance activities under Alternative 2D, relative to the No Action Alternative (ELT and LLT) would result in an increased frequency of exceedance of the CALFED Drinking Water Program long-term bromide goal of 50 μg/L at the S. Fork Mokelumne River at Staten Island, Franks Tract, Sacramento River at Emmaton, San Joaquin River at Antioch, Sacramento River at Mallard Island, and North Bay Aqueduct at Barker Slough. The frequency of exceedance of the 100 μg/L threshold for protection against the formation of disinfection byproducts in treated drinking water would increase by 4% at Franks Tract, 3% at Antioch, and 1% at Staten Island, Mallard Island, and Barker Slough. However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island, San Joaquin River at Buckley Cove, and North Bay Aqueduct at Barker Slough; long-term average bromide concentrations at the other assessment locations will be the same or decrease. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island would be less than the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts, and the increase in the San Joaquin River at Buckley Cove and North Bay Aqueduct at Barker Slough would be minimal (<2%). Thus, these increased bromide concentrations are not expected to result in adverse effects to MUN beneficial uses, or any other beneficial use, at these locations. Based on these findings, this effect is determined to not be adverse.

CEQA Conclusion: While greater water demands under Alternative 2D would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the San Joaquin River, the eastside tributaries, and the various reservoirs of the related watersheds, as described for Alternative 4 (see Section 8.3.3.9).

Under Alternative 2D there would be an increased frequency of exceedance of the 50 μg/L and 100 μg/L bromide thresholds for protecting against the formation of disinfection byproducts in treated drinking water at the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. The North Bay Aqueduct at Barker Slough also would have an increased exceedance of the 100 μg/L threshold (from 0% to 1%). However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island and decrease at all other assessment locations. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island (55 μg/L) would be less than the 100 μg/L believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts. Further, as described for Alternative 4 (see Section 8.3.3.9), the use of seasonal intakes at Antioch and Mallard Island is largely driven by acceptable water quality, and thus has historically been opportunistic and opportunity to use these intakes would remain. Thus, these increased bromide concentrations would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Long-term average bromide concentrations at the Banks and Jones pumping plants are predicted to decrease by as much as 50% relative to Existing Conditions and there would be less frequent exceedance of bromide concentration thresholds.

Based on the above, Alternative 2D would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. Alternative 2D would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 μg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 μg/L assessment threshold concentration would be 6% or less at all locations assessed, which is considered to be less than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the Alternative 2D would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not CWA Section 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant. No mitigation is required.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Therefore, as they pertain to bromide, implementation of these Environmental Commitments would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

Environmental Commitment 4 would result in some tidal habitat restoration, however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable bromide concentration changes.

In summary, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D relative to the No Action Alternative (ELT and LLT), would have negligible, if any, effects on bromide concentrations. Therefore, the effects on bromide from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D would not present new or substantially changed sources of bromide to the affected environment. Some Environmental Commitments may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 2D on chloride concentrations in reservoirs and rivers upstream of the Delta would be the similar to those effects described for Alternative 4 (see Section 8.3.3.9). Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. There would be no expected change to the sources of chloride in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial chloride increases. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, Alternative 2D in the ELT would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 2D in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect chloride sources in these areas.

Delta

Estimates of chloride concentrations at Delta assessment locations were generated using a mass balance approach and EC-chloride relationships and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in chloride at Delta assessment locations based on both approaches.

Modeling of chloride using both the mass balance approach and EC-chloride relationship predicts that Alternative 2D in the ELT would result in reduced long-term average chloride concentrations, relative to Existing Conditions, for the 16-year period modeled at all assessment locations except for the S. Fork Mokelumne River at Staten Island. The increase in long-term average chloride concentration at Staten Island would be 1 mg/L (9%) based on the mass balance modeling and 1 mg/L (3%) based on the EC-chloride relationship (Appendix 8G, *Chloride*, Tables Cl-73 and Cl-74). These increases are extremely small in absolute terms and relative to applicable water quality objectives, and are within the estimated modeling uncertainty. The results differ from Alternative 4, under which there would be increased long-term average chloride concentrations also at the North Bay Aqueduct at Barker Slough. The change in long-term average chloride concentrations relative to the No Action Alternative (ELT) would be similar to those relative to Existing Conditions.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at Antioch and Contra Costa Pumping Plant #1. The modeled frequency of objective exceedance would decrease at the Contra Costa Pumping Plant #1 from 7% of years under Existing Conditions to 0% of years under Alternative 2D in the ELT (Appendix 8G, *Chloride*, Table Cl-64).

Evaluation of the 250 mg/L Bay-Delta WQCP objective for chloride utilized results from both the mass balance approach and EC-chloride relationship. The basis for the evaluation was the predicted number of days the objective would be exceeded for the modeled 16-year period.

Based on the mass balance approach, there would be a decreased frequency of exceedance of the 250 mg/L objective under Alternative 2D, relative to Existing Conditions, at all locations except in the Sacramento River at Mallard Island and the San Joaquin River at Antioch. In the Sacramento

River at Mallard Island, the frequency of objective exceedance would increase from 85% under Existing Conditions to 86% under Alternative 2D for the entire period modeled (Appendix 8G, *Chloride*, Table Cl-81). In the San Joaquin River at Antioch, there would be an increase in chloride objective exceedance during the drought period modeled, from 82% to 83%. These changes are within the uncertainty of the modeling approach.

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 2D, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions, to 2% of modeled days under Alternative 2D (Appendix 8G, *Chloride*, Table Cl-63).

The mass balance results also indicate reduced assimilative capacity with respect to the 250 mg/L objective during certain months and at certain locations. In the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in March and April of up to 14% for the 16-year period modeled, and 53% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-75). Assimilative capacity at the Contra Costa Pumping Plant #1 also would be reduced, in February through April and June, by up to 5% for the entire period modeled and in June by 5% for the drought period modeled. These estimates include the effect of climate change and sea level rise, as well as the alternative. Comparisons to the No Action Alternative (ELT) below provide an assessment of the effect of the alternative alone.

When utilizing the EC-chloride relationship to model chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-76 and Cl-82). However, the EC-chloride relationships generally predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

CWA Section 303(d) Listed Water Bodies–Relative to Existing Conditions

Tom Paine Slough in the southern Delta is on the state's CWA Section 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough, would be generally similar under Alternative 2D in the ELT relative to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, *Chloride*, Figure Cl-17).

Suisun Marsh also is on the state's CWA Section 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase by <10% under Alternative 2D in the ELT relative to Existing Conditions in March and April at the Sacramento River at Mallard Island (Appendix 8G, *Chloride*, Figure Cl-18), at Collinsville (Appendix 8G, *Chloride*, Figure Cl-19), and in Montezuma Slough at Beldon's Landing (Appendix 8G, *Chloride*, Figure Cl-20), and remain similar or decrease in all other months. Chloride levels in Suisun Marsh are highly dynamic on a sub-daily basis as a result of tidal influences. The changes identified above are small relative to normal day-to-day variability in chloride in Suisun Marsh. For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses. These changes reflect the effect of climate change and sea level rise, as well as the alternative. Comparisons to the No Action Alternative (ELT) below provide an assessment of the effect of the alternative alone.

Municipal Beneficial Uses Relative to No Action Alternative (ELT)

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated from EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 2D in the ELT, the modeled frequency of objective exceedance would not change at the Contra Costa Pumping Plant #1—both the No Action Alternative (ELT) and Alternative 2D in the ELT would have 0% exceedance (Appendix 8G, *Chloride*, Table Cl-64).

Based on the mass balance approach, the frequency of exceedance of the 250 mg/L objective under Alternative 2D in the ELT would be the same, or would decrease, at all locations relative to the No Action Alternative (ELT) (Appendix 8G, *Chloride*, Table Cl-81).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 2D, the modeled frequency of objective exceedance would decrease, from 8% of modeled days under the No Action Alternative (ELT), to 2% of modeled days under Alternative 2D (Appendix 8G, *Chloride*, Table Cl-63).

Estimates of long-term use of assimilative capacity using the mass balance results indicated the potential for reduced assimilative capacity with respect to the 250 mg/L objective for certain months and locations. Calculations using the long-term monthly and annual average concentrations showed that in the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in April of 15% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-75). However, this approach used long-term average chloride concentrations, which can be heavily influenced by changes in a small number of years when chloride concentrations would already be very high. Additionally, when long term averages are just below the objective, very small changes in chloride that are within the modeling uncertainty can result in very high estimates of use of assimilative capacity. To further investigate the potential for water quality degradation with respect to chloride, the concentrations of chloride during individual water years was examined.

This further examination was limited to the mass balance approach, since when utilizing the EC-chloride relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity were similar to those discussed for the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-82 and Cl-76). However, utilizing the EC-chloride relationships generally predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Figure Cl-21 in Appendix 8G, *Chloride,* shows chloride concentrations in April during the 5-year drought period (1987–1991) at Antioch, where Table Cl-75 in Appendix 8G indicated 15% use of assimilative capacity. The figure shows that during 3 of the 5 years, chloride concentrations increased relative to the No Action Alternative (ELT) and decreased in the other 2 years. The absolute differences estimated are fairly small and may be within modeling uncertainty. Figures Cl-22 and Cl-23 in Appendix 8G show a box and whisker plot and exceedance plot for April at Antioch for all dry and critical water years modeled (not just the 1987–1991 drought period). These graphs show that while the median chloride concentration is increased relative to the No Action Alternative (ELT), the maximum, 25th percentile, and 75th percentile values are all decreased. Based on this analysis, long-term degradation is not expected at Antioch in April during drought years.

Based on the low level of water quality degradation estimated for the western Delta, and the lack of exceedance of water quality objectives, Alternative 2D is not expected to have substantial adverse effects on municipal and industrial beneficial uses in the western Delta.

CWA Section 303(d) Listed Water Bodies–Relative to No Action Alternative (ELT)

With respect to the state's CWA Section 303(d) listing for chloride, Alternative 2D would generally result in changes similar to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis, based on changes that would occur in Old River at Tracy Road (Appendix 8G, *Chloride*, Figure Cl-17). Modeling indicated that monthly average chloride concentrations at source water channel locations for the Suisun Marsh remain similar or decrease relative to the No Action Alternative (ELT) (Appendix 8G, Figures Cl-18, Cl-19, and Cl-20). For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses.

The effects of Alternative 2D in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in chloride in the west Delta. Small increases in chloride concentrations may occur in some areas, but it is not expected that these increases would cause exceedance of Bay-Delta WQCP objectives of cause substantial long-term degradation that would impact municipal and industrial beneficial uses.

SWP/CVP Export Service Areas

Under Alternative 2D in the ELT, long-term average chloride concentrations at the Banks and Jones pumping plants, based on the mass balance analysis of modeling results for the 16-year period, would decrease relative to Existing Conditions. Chloride concentrations would be reduced by 49% at Banks pumping plant (Appendix 8G, *Chloride*, Table Cl-73). At Jones pumping plant, chloride concentrations would be reduced 47% (Appendix 8G, Table Cl-73). The frequency of exceedances of applicable water quality objectives would decrease relative to Existing Conditions, for both the 16-year period and the drought period modeled (Appendix 8G, Table Cl-81). The chloride concentration changes relative to the No Action Alternative (ELT) would be similar. Consequently, water exported into the SWP/CVP Export Service Areas would generally be of similar or better quality with regard to chloride relative to Existing Conditions and the No Action Alternative (ELT). Results of the modeling approach which utilized a EC-chloride relationship are consistent these results, and assessment of chloride using these modeling output results in the same conclusions as for the mass balance approach (Appendix 8G, *Chloride*, Tables Cl-74 and Cl-82).

Commensurate with the reduced chloride concentrations in water exported to the SWP/CVP Export Service Area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate chloride concentrations at Vernalis.

The effects of Alternative 2D in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative (ELT and LLT), Alternative 2D would not result in substantially increased chloride concentrations in the Delta on a long-term average that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Additional exceedance of the 150 mg/L and 250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Based on these findings, this effect is determined to not be adverse.

***CEQA Conclusion*:** Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under Alternative 2D relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, Alternative 2D would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 2D would not result in substantially increased chloride concentrations in the Delta on a long-term average basis that would result in adverse effects on the municipal and industrial water supply beneficial use. Additional exceedance of the 150 mg/L and 250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use.

Chloride concentrations would be reduced under Alternative 2D in water exported from the Delta to the SWP/CVP Export Service Areas thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 2D would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 2D maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas

Based on these findings, this impact is determined to be less than significant. No mitigation is required. Despite the fact that no mitigation is required, DWR proposed to further reduce any impacts by implementing Mitigation Measure WQ-7e.

Mitigation Measure WQ-7e: Implement Terms of the Contra Costa Water District Settlement Agreement

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D would present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Consequently, as they pertain to chloride, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement relative to the No Action Alternative (ELT and LLT). Therefore, the effects on chloride from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: Implementation of the Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. Replacement of irrigated agricultural land uses in the Delta with habitat restoration may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance

As described in detail for Alternative 4 (see Section 8.3.3.9), DO levels are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

As described for Alternative 4, amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under Alternative 2D (ELT and LLT) to substantially alter DO levels relative to Existing Conditions or the No Action Alternative (ELT and LLT). Further, the rivers upstream of the Delta are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under Alternative 2D would not be expected to cause DO levels to be outside of the range seen historically. Flow changes that would occur under Alternative 2D would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative (ELT and LLT).

Also as described for Alternative 4, salinity changes would generally have relatively minor effects on Delta DO levels. Further, the relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative (ELT and LLT), such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses. Similarly, increased temperature under Alternative 2D (ELT and LLT), which would be due to climate change, would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Similar to Alternative 4, flows in the San Joaquin River at Stockton were evaluated under Alternative 2D and are shown in Figure 8-65b. The figure shows that while flows do would change somewhat, they are would generally be within the range of flows seen under Existing Conditions and the No Action Alternative. Reports indicate that the aeration facility performs adequately under the range of flows from 250–1,000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will would likely still be located appropriately to keep DO levels above Basin Plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact adverse effect on DO in the Deep Water Ship Channel. It is expected that DO levels in the Deep Water Ship Channel, which is CWA Section 303(d) listed as impaired due to low DO, would remain similar to those under Existing Conditions and the No Action Alternative (ELT and LLT) or improve as TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act Section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No Action Alternative (ELT and LLT), as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

In the SWP/CVP Export Service Areas, the primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions or the No Action Alternative (ELT and LLT) due to water quality regulations, canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

NEPA Effects: Because DO levels are not expected to change substantially relative to the No Action Alternative (ELT and LLT), the effects on DO from implementing Alternative 2D (ELT and LLT) are determined to not be adverse.

CEQA Conclusion: The effects of Alternative 2D on DO levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for Alternative 4 (see Section 8.3.3.9). Reservoir storage reductions that would occur under Alternative 2D, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state regulates the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters, relative to Existing Conditions. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. The increased habitat provided by these Environmental Commitments could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying. However, the areal extent of new habitat would be small relative to existing and No Action Alternative habitat areas, and similar habitat existing in the Delta is not identified as contributing to adverse DO conditions. The remaining Environmental Commitments would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances. Therefore, the effects on DO from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

CEQA Conclusion: It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D would not be substantially different from existing DO conditions, because these would contribute to a minimal, localized change in oxygen-demanding substances associated with habitat restoration, if at all. Therefore, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 2D on EC levels in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). The extent of new urban growth would be less in the ELT, thus discharges of EC-elevating parameters in runoff and wastewater discharges to water bodies upstream of the Delta would be expected to be less than in the LLT. However, the state is regulating point source discharges of EC-related parameters and implementing a program to further decrease loading of EC-related parameters to tributaries. Based on these considerations, and those described in Section 8.3.3.9, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

For the San Joaquin River, increases in EC levels under Alternative 2D could occur, but would be slightly less than those described for Alternative 4 (see Section 8.3.3.9). This is because the effects of climate change on flows, which could affect dilution of high EC discharges, would be less in the ELT. The implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis are expected to contribute to improved EC levels. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions would not be expected to be of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Initial review of modeling results indicated that Alternative 2D would potentially result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, relative to Existing Conditions, and San Joaquin River at San Andreas Landing and Prisoners Point, relative to both Existing Conditions and No Action Alternative (ELT) (Appendix 8H, *Electrical Conductivity*, Table EC-26). To understand and interpret these results, considerations must be made regarding uncertainty in the modeling and results from sensitivity analyses. In addition, modeling results indicate there would be small increases in long-term monthly average EC at modeled Suisun Marsh locations relative to Existing Conditions. These locations are addressed in detail below At all other locations, the level of exceedance and modeled average EC levels under the alternative was approximately equivalent or lower than under Existing Conditions and the No Action Alternative (ELT).

Sacramento River at Emmaton

Modeling results indicated that the Emmaton EC objective would be exceeded more often under Alternative 2D than under Existing Conditions, but less often relative to the No Action Alternative (ELT). The modeling results also indicated that increases in EC could cause substantial water quality degradation in summer months of below normal, dry and critical water years. However, these increases in exceedance of the objective and degradation are expected to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Delta Cross Channel operation. Further discussion is provided below.

Modeling results indicated that the percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 7%; there would be a 5% decrease relative to the No Action Alternative (ELT), from 12% to 7% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The percentage of days out of compliance would increase from 11% under Existing Conditions to 15%; there would be a 6% decrease relative to the No Action Alternative (ELT), from 21% to 15% (Appendix 8H, Table EC-26). The comparison of the alternative to Existing Conditions reflects changes due both to operation of the alternative as well as effects of sea level rise due to climate change. The comparison of the alternative to the No Action Alternative (ELT) reflects changes in EC due solely to operations of the alternative. Based on the comparison to the No Action Alternative (ELT), the alternative would not contribute to additional exceedance of the EC objective at Emmaton.

The results of the EC modeling indicate there would be months with substantial degradation relative to the No Action Alternative (ELT), particularly during the drought period modeled. Long-term average EC levels at Emmaton would increase in the months of July through September by 3–7% for the entire period modeled (1976–1991), and in the months of July and August by 4–29% during the drought period modeled (1987–1991), relative to the No Action Alternative (ELT) (Appendix 8H, *Electrical Conductivity*, Table EC-30). The largest increases in EC would occur in below normal, dry and critical water year types. These periods of degradation are expected to be addressed via real-time operations. The level to which modeling output depicts degradation of water quality with respect to EC is primarily a function of the modeling not being able to fully capture how the system would be operated in real-time to minimize or avoid such degradation

Discussions with SWP operators indicated that real-time operations would ensure that the Bay-Delta WQCP EC objectives at Emmaton, applicable from April 1 through August 15, would be met. In latter August and September, the Threemile Slough standard in the North Delta Water Agency Agreement and the Bay-Delta WQCP municipal and industrial objective at Rock Slough are in effect. During this period of the year, the coordinated operations of the SWP/CVP system strives to meet both standards in the most water-efficient method available to the CVP and SWP. Real-time operation would result in less EC degradation than depicted by modeling output because in order to comply with Bay-Delta WQCP objectives and the the North Delta Water Agency Agreement during the summer period, operators could, for example, increase upstream reservoir releases for necessary periods of time, reduce North Delta diversions, and/or close (short-term) the Delta Cross Channel. These options as well as real-time and forecasted tides, winds and barometric pressure are considered when the projects schedule daily operations, which the modeling does not fully capture.

Alternaltive 2D does not change the Bay-Delta WQCP objectives or the the North Delta Water Agency Agreement which are primary drivers of operations and resulting water quality in the Sacramento River at at Emmaton during late August and September. Therefore, the EC degradation at Emmaton that would occur upon implementation of Alternative 2D would be lesser than that shown by the modeling and would not be expected to differ substantially from that which would occur under the No Project Alternative because the compliance targets are not changing due to Alternative 2D during these months and real-time operations would achieve the compliance targets.

The modeling results also show that in the remaining months there would be decreases in EC relative to the No Action Alternative (ELT) of 2–27% for the entire period modeled and 2–32% for the drought period modeled. These decreases would contribute to the long-term average EC levels decreasing by 10% for the entire period modeled and 9% for the drought period modeled (Appendix 8H, Table EC-30).

San Joaquin River at San Andreas Landing

Alternative 2D is not expected to have adverse effects on EC in the San Joaquin River at San Andreas Landing, relative to Existing Conditions and the No Action Alternative (ELT). Modeling results estimated that the percentage of days the San Andreas Landing EC objective would be exceeded would increase by <1% relative to Existing Conditions, and the percentage of days out of compliance would increase from 1% under Existing Conditions to 2% (Appendix 8H, *Electrical Conductivity*, Table EC-26). San Andreas Landing average EC would decrease 15% for the entire period modeled and 12% during the drought period modeled, relative to Existing Conditions (Appendix 8H, Table EC-30). Results relative to the No Action Alternative (ELT) were similar (Appendix 8H, Table EC-30).Sensitivity analyses performed for Alternative 4 Scenario H3 at the LLT indicate that many of these exceedances are likely modeling artifacts, and the small number of remaining exceedances would be small in magnitude, lasting only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP). These sensitivity analyses were only run at the LLT, but it is expected that the findings can generally be extended to the ELT, because the factors affecting salinity findings in the sensitivity analysis (e.g., modeling assumptions, physical hydrodynamic mechanisms) are similar between the ELT and LLT (see Appendix 8H, Attachment 1).

San Joaquin River at Prisoners Point

Modeling results indicated that the EC objective that applies to the San Joaquin River between Jersey Point and Prisoners Point would be exceeded at Prisoners Point more often under Alternative 2D than under Existing Conditions and the No Action Alternative (ELT). However, these exceedances are expected to be able to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Head of Old River Barrier management. Further discussion is provided below.

Modeling results estimated that the percentage of days the Prisoners Point EC objective would be exceeded would increase from 6% under Existing Conditions, or 2% under the No Action Alternative (ELT), to 12%, and the percentage of days out of compliance with the EC objective would increase from 10% under Existing Conditions, or 2% under the No Action Alternative (ELT), to 13% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The magnitude of the exceedances is estimated to be very small—the objective is 440 μmhos/cm, and the EC during times of exceedance was generally between 440 and 600 μmhos/cm—and the exceedances generally occurred in drier water years (4 of the 5 years in which there were exceedances were dry water year type), when flows would be lower (Appendix 8H, Figures EC-1 through EC-5). During these times, the EC in the San Joaquin River at Vernalis is greater than in the Sacramento River entering the Delta, and is high enough on its own to cause an exceedance of the Prisoners Point EC objective.

There are two main drivers of the increase in exceedances under the alternative: an increase in San Joaquin River flow at Prisoners Point during April and May under the alternative, relative to Existing Conditions and the No Action Alternative (ELT), and a reduction in the amount of Sacramento River water moving past Prisoners Point under the alternative. The result is increased San Joaquin River water at Prisoners Point, and a reduction in the dilution that the Sacramento River provides the higher EC San Joaquin River. The increase in San Joaquin River flow at Prisoners Point is due to a reduction in pumping from the south Delta under the alternative, as well as due to the presence of the Head of Old River Barrier, which increases flow in the San Joaquin River downstream of Old River by preventing flow from entering Old River. The reduction in Sacramento River water influence is due to less pumping at the south Delta pumping plants (i.e., greater pumping draws more Sacramento River water through the Delta).

Sensitivity analyses conducted for Alternative 4 Scenario H3 at the LLT indicated that if the Head of Old River Barrier was open in April and May, exceedances would be reduced by about 5 percentage points. These sensitivity analyses were only run at the LLT, but it is expected that the findings can generally be extended to the ELT. Results of the sensitivity analyses indicate that the exceedances are partly due also to operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H, Attachment 1, for more discussion of these sensitivity analyses). Appendix 8H, Attachment 2, contains a more detailed assessment of the likelihood of these exceedances estimated via modeling adversely affecting aquatic life beneficial uses. Specifically, Appendix 8H, Attachment 2, discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination for those alternatives. Additionally, by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, EC levels at Prisoners Point would likely be decreased to a level that would not adversely affect aquatic life beneficial uses.

Suisun Marsh

For Suisun Marsh October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Modeling results indicate that average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March and April relative to Existing Conditions, by 0.1 mS/cm (Appendix 8H, *Electrical Conductivity*, Table EC-32). In Montezuma Slough at National Steel, average EC levels would increase in March through May by 0.1 mS/cm (Appendix 8H, Table EC-33). There would be similarly small increases in long-term average EC in the months of March through May in Montezuma Slough near Beldon’s Landing, Chadbourne Slough near Sunrise Duck Club, and Suisun Slough near Volanti Slough, ranging 0.1–0.3 mS/cm depending on month and location (Appendix 8H, Tables EC-34 through EC-36). Relative to the No Action Alternative (ELT), the modeled long-term average EC under the alternative would be similar or lower from October through May for these locations (Appendix 8H, Tables EC-32 through EC-36).

The Suisun Marsh EC objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). Long-term average EC increases relative to Existing Conditions may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the Marsh. Given the Bay-Delta WQCP narrative objective regarding “equivalent or better protection” in lieu of meeting specific numeric objectives, the small increases in EC under Alternative 2D, relative to Existing Conditions, would not be expected to adversely affect beneficial uses of Suisun Marsh. While Suisun Marsh is CWA Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) relative to the daily fluctuations in EC levels as to not be measurable and beneficial uses would not be adversely affected.

Further, the EC changes in Suisun Marsh relative to Existing Conditions reflect the influence of both operations of the alternative and sea level rise due to climate change, whereas the changes relative to the No Action Alternative (ELT) are due solely to operations of the alternative. As described above, there would be no increase in the long-term average EC at modeled Suisun Marsh locations, and for some locations long-term average EC would decrease. Therefore, it is expected that this alternative would not contribute to exceedances of EC objectives or additional impairment of beneficial uses, as affected by EC or other salinity-related parameters.

The effects of Alternative 2D in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in EC in the west Delta, but this requirement would not be due to the alternative.

SWP/CVP Export Service Areas

Under Alternative 2D, at the Banks and Jones pumping plants, there would be no exceedance of the Bay-Delta WQCP s 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-27). Relative to Existing Conditions, average EC levels under Alternative 2D would decrease 28–29% for the entire period modeled and 27% during the drought period modeled (Appendix 8H, Table EC-30). Relative to the No Action Alternative (ELT), average EC levels would similarly decrease, by 25–26% for the entire period modeled and 25% during the drought period modeled (Appendix 8H, Table EC-30). Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 2D would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas. Rather, Alternative 2D would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC Alternative 2D would result in lower average EC levels relative to Existing Conditions and the No Action Alternative (ELT) and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

The effects of Alternative 2D in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

NEPA Effects: In summary, based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the western, interior, or southern Delta. However, modeling results indicate that there could be increased long-term and drought period average EC levels during the summer months that would occur in the western Delta (i.e., in the Sacramento River at Emmaton) under Alternative 2D relative to the No Action Alternative (ELT), that could contribute to adverse effects on the agricultural beneficial uses. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to increase under Alternative 2D, relative to the No Action Alternative (ELT), and thus it is not expected to contribute to additional beneficial use impairment. The increases in EC in the Sacramento River at Emmaton, particularly during summer months of below normal, dry and critical water years, and the additional exceedances of water quality objectives in the San Joaquin River at Prisoners Point constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects.

CEQA Conclusion: River flow rate and reservoir storage reductions that would occur under Alternative 2D, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 2D would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas, and there would be no exceedance of the Bay-Delta WQCP EC objective for this area of the Delta. Average EC levels for the entire period modeled would decrease at both the Banks and Jones pumping plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Further, relative to Existing Conditions, Alternative 2D would not result in substantial increases in long-term average EC in Suisun Marsh. Thus, EC levels in Suisun Marsh are not expected to further degrade existing EC levels and thus would not contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, any changes in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to change substantially under Alternative 2D, relative to Existing Conditions, and thus it is not expected that they would contribute to additional beneficial use impairment.

In the Plan Area, Alternative 2D is not expected to result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded, except for at the San Joaquin River at Prisoners Point (fish and wildlife objective; 6% increase). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. However, by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, EC levels at Prisoners Point would likely be decreased to a level that would not adversely affect aquatic life beneficial uses.

In the Sacramento River at Emmaton, large monthly average increases in EC were modeled to occur during the summer months of the drought period, and more generally in below normal, dry and critical water year types. The increases in drought period average EC levels modeled could cause substantial water quality degradation that would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The comparison to Existing Conditions reflects changes in EC due to both Alternative 2D operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton would be due in part to the effects of climate change/sea level rise, and in part due to Alternative 2D operations. This is evidenced by the significant effects expected in the No Action Alternative (ELT) at Emmaton relative to Existing Conditions, as well as the fact that a lesser level of adverse effects is expected at Emmaton under Alternative 2D relative to the No Action Alternative (ELT). During summer of below normal, dry and critical water years, additional flow in the Sacramento River at Emmaton would reduce or eliminate increases in EC. It is expected that for July–August of below normal, dry and critical water years, real-time operations that would include more precise management of upstream reservoir realeases on a daily basis and less pumping from the north Delta intakes and greater reliance on south Delta intakes than that modeled would allow for enough flow in the Sacramento River at Emmaton to reduce water quality degradation to levels closer to the No Action Alternative that would not be expected to adversely affect beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is CWA Section 303(d) listed for elevated EC and the increased EC degradation that was modeled in the western Delta could make beneficial use impairment measurably worse. Based on these findings, this impact in the Plan Area is considered to be significant. Implementation of Mitigation Measure WQ-11 would be expected to reduce these effects to a less-than-significant level.

Mitigation Measure WQ-11: Avoid or Minimize Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 4A.

Mitigation Measure WQ-11e: Adaptively Manage Diversions at the North and South Delta Intakes to Reduce or Eliminate Water Quality Degradation in Western Delta

Please see Mitigation Measure WQ-11e under Impact WQ-11 in the discussion of Alternative 4A.

Mitigation Measure WQ-11f: Adaptively Manage Head of Old River Barrier and Diversions at the North and South Delta Intakes to Reduce or Eliminate Exceedances of the Bay-Delta WQCP Objective at Prisoners Point

Please see Mitigation Measure WQ-11f under Impact WQ-11 in the discussion of Alternative 4A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15 and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

Environmental Commitment 4 would result in some tidal habitat restoration, however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable EC changes.

In summary, implementation of the Environmental Commitments would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment. Therefore, the effects on EC from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 2D would not present new or substantially changed sources of EC to the affected environment. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the Alternative 2D on mercury levels in surface waters upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors that affect mercury concentrations in surface waters upstream of the Delta are similar under Alternatives 4 and 2D. The changes in flow in the Sacramento River under Alternative 2D relative to Existing Conditions and the No Action Alternative (ELT) would not be of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore, mercury loading should not be substantially different due to changes in flow. In addition, even though they may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but would not change substantially because the anticipated changes in flow are not expected to substantially change mercury loading relative to Existing Conditions or the No Action Alternative (ELT).

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

Delta

The effects of Alternative 2D on waterborne concentrations of mercury (Appendix 8I, *Mercury*, Table I-17) and methylmercury (Appendix 8I, Table I-18), and fish tissue mercury concentrations for largemouth bass fillet (Appendix 8I, Tables I-21a and I-21b) were evaluated for nine Delta locations.

Increases in long-term average mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) would be very small, 0.3 ng/L or less. Also, use of assimilative capacity for mercury relative to the 25 ng/L ecological threshold under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT), would be very low, approximately 2% or less, as a long-term average, for all Delta locations (Appendix 8I, *Mercury*, Table I-24). These concentration changes and small changes in assimilative capacity for mercury are not expected to result in adverse (or positive) effects to beneficial uses.

Changes in methylmercury concentrations in water also are expected to be very small. The greatest annual average methylmercury concentration under Alternative 2D would be 0.166 ng/L for the San Joaquin River at Buckley Cove, for the drought period modeled, which would be slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (ELT) (0.168 ng/L) (Appendix 8I, *Mercury*, Table I-18). All methylmercury concentrations in water were estimated to exceed the TMDL guidance objective of 0.06 ng/L under Existing Conditions and, therefore, no assimilative capacity exists.

Fish tissue estimates for largemouth bass fillet show small or no increases in mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, *Mercury*, Tables I-21a and I-21b). Concentrations expected for Alternative 2D, with Equation 1, show increases of 7% or less, relative to Existing Conditions and the No Action Alternative (ELT), in all years (Appendix 8I, Table I-21a). Concentrations expected with Equation 2 show increases of 10% or less relative to Existing Conditions and the No Action Alternative (ELT) in all years (Appendix 8I, Table I-21b).

Because the increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I, *Mercury*, for a complete discussion of the uncertainty associated with the fish tissue estimates. Briefly, the bioaccumulation models contain multiple sources of uncertainty associated with their development. These are related to: analytical variability; temporal and/or seasonal variability in Delta source water concentrations of merthylmercury;

interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and limited sample size (both in number of fish and time span over which the measurements were made), among others. Although there is considerable uncertainty in the models used, the results serve as a reasonable approximations of a very complex process. Considering the uncertainty, small (i.e., <20–25%) increases or decreases in modeled fish tissue mercury concentrations at a low number of Delta locations (i.e., 2–3) should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual adverse effects. Larger increases, or increases evident throughout the Delta, can be interpreted as more reliable indicators of potential adverse effects.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 2D at the Jones and Banks pumping plants would be lower than Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, *Mercury*, Tables I-17 and I-18). Therefore, there would be increased assimilative capacity for mercury at these locations (Appendix 8I, Table I-24).

The largest improvements in largemouth bass tissue mercury concentrations and Exceedance Quotients ([EQs]; modeled tissue divided by TMDL guidance concentration) for Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT) at any location within the Delta are expected for the Banks and Jones pumping plants export pump locations. Concentrations expected for Alternative 2D at the export pump locations with Equation 1 in all years show decreases relative to Existing Conditions (10% to 12%) and relative to the No Action Alternative (ELT) (11% to 13%) (Appendix 8I, *Mercury*, Table I-21a). Concentrations expected for Alternative 2D at the export pump locations with Equation 2 in all years show decreases relative to Existing Conditions (14% to 17%) and relative to the No Action Alternative (ELT) (15% to 18%) (Appendix 8I, Table I-21b).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

***NEPA Effects*:** Based on the above discussion, Alternative 2D would not cause concentrations of mercury and methylmercury in water and fish tissue in the affected environment to be substantially different from the No Action Alternative (ELT and LLT) and, thus, would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to the No Action Alternative

(ELT and LLT), Alternative 2D would not be expected to increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, the effects of Alternative 2D on mercury in the affected environment are considered to be not adverse.

CEQA Conclusion**:** Under Alternative 2D, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta would not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record under Alternative 2D would be very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show small differences would occur among sites for Alternative 2D as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP/CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 2D, as compared to Existing Conditions.

As such, Alternative 2D is expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 2D would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects**:** The potential types of effects on mercury resulting from implementation of the Environmental Commitments under Alternative 2D would be generally similar to those described under Alternative 4 (see Section 8.3.3.9). However, the magnitude of effects on mercury and methylmercury at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service Areas related to habitat restoration would be considerably lower than described for Alternative 4. This is because the amount of habitat restoration to be implemented under Alternative 2D would be very low compared to the total proposed restoration area that would be implemented under

Alternative 4. The small amount of habitat restoration to be implemented under Alternative 2D may occur on lands in the Delta formerly used for irrigated agriculture. Habitat restoration proposed under Alternative 2D has the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the vicinity of the restored habitat areas. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, there remain uncertainties related to site-specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta in the vicinity of the restored areas. Therefore, the effect of Environmental Commitments 3, 4, 6–12, 15, and 16 on mercury and methylmercury is considered to be adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. However, in the Delta, due to the small amount of tidal restoration areas proposed, relative to Existing Conditions, uptake of mercury from water and/or methylation of inorganic mercury may increase in localized areas as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Although not quantifiable, on a local level, increases in methylmercury concentrations may be measurable. Methylmercury is CWA Section 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore, this impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (in Section 8.3.3.9), nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the reservoirs and rivers relative to the magnitude of the point and non-point source discharges, and there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to Existing Conditions or the No Action

Alternative (ELT), are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento River watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49; Figure 2 in Appendix 8J, *Nitrate*). Under Alternative 2D, long-term average flows at Vernalis would decrease an estimated 1% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (ELT). Given the relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any negligible changes in nitrate concentrations that may occur under Alternative 2D in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to nitrate.

Delta

Mass balance calculations indicate that under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 34). Although changes at specific Delta locations and for specific months may be substantial on a relative basis (Appendix 8J, Table 39), the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds (see *Nitrate* under Section 8.3.1.7, *Constituent-Specific Considerations Used in the Assessment*). Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 Delta assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentrations would be somewhat reduced under Alternative 2D relative to Existing Conditions, and slightly increased relative to the No Action Alternative (ELT). No additional exceedances of the MCL are anticipated at any location under Alternative 2D (Appendix 8J, Table 34).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under Alternative 2D would be low or negligible (i.e., ≤4%) in comparison to both Existing Conditions and the No Action Alternative (ELT), for all locations and months, for all modeled years (1976–1991), and for the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 40).

As described for Alternative 4 (see Section 8.3.3.9), actual nitrate concentrations would likely be higher than the modeling results indicate in certain locations under Alternative 2D. This is the mass balance modeling does not account for contributions from the SRWTP, which would be implementing nitrification/partial denitrification, or Delta wastewater treatment plant dischargers that practice nitrification, but not denitrification. However, for the reasons described for Alternative 4, any increases in nitrate concentrations that may occur at certain locations within the Delta under Alternative 2D would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to nitrate.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Assessment of effects of Alternative 2D on nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate at the Banks and Jones pumping plants. Results of the mass balance calculations indicate that relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations at Banks and Jones pumping plants under Alternative 2D are anticipated to decrease on a long-term average annual basis by 34% at the Banks pumping plant and 36% at the Jones pumping plant (Appendix 8J, *Nitrate*, Table 39). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) would be small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Areas, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.2 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP/CVP Export Service Areas. No additional exceedances of the MCL are anticipated under Alternative 2D relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8J, Table 34). On a monthly average basis and on a long-term annual average basis, for all modeled years and for the drought period only, use of assimilative capacity available under Existing Conditions and the No Action Alternative (ELT), relative to the 10 mg/L-N MCL, would be negligible (≤2%) for both Banks and Jones pumping plants (Appendix 8J, Table 38).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any increases in nitrate concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regard to nitrate.

NEPA Effects: Modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. In the Delta, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any Delta location, and use of assimilative capacity available under the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, would be low. Long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to differ negligibly relative to the No Action Alternative

(ELT and LLT) and no additional exceedances of the 10 mg/L-N MCL are anticipated. Therefore, the effects on nitrate from implementing water conveyance facilities are considered to be not adverse.

CEQA Conclusion: Nitrate concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mass balance calculations indicate that under Alternative 2D, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, would be low or negligible (i.e., ≤4%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate concentrations at the Banks and Jones pumping plants. Results of the mass balance calculations indicate that under Alternative 2D, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the 10 mg/L-N MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL would be negligible (i.e., ≤2%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under Alternative 2D relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Some habitat restoration activities included in Environmental Commitments 3, 4, and 6–11 would occur on lands within the Delta formerly used for agriculture. As discussed for Impact WQ-2, increased biota that may result in those areas may increase ammonia, which in turn may be converted to nitrate by established microbial communities. However, the areal extent of the new habitat implemented for the Environmental Commitments would be less than the existing and No Action Alternative habitat areas, and similar habitat exists currently in the Delta and is not identified as contributing to adverse nitrate conditions. Thus, these land use changes would not be expected to substantially increase nitrate concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect nitrate sources or loading. Based on these findings, the effects on nitrate from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

***CEQA Conclusion*:** Land use changes that would occur from the Environmental Commitments are not expected to substantially increase nitrate concentrations, because the amount of area to be converted would be small relative to existing habitat, and existing habitats are not known for contributing to adverse nitrate conditions. Thus, it is expected that implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 2D on DOC concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 because factors affecting DOC concentrations in these water bodies would be similar. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under Alternative 2D would not be expected to cause substantial long-term changes in DOC concentrations in the water bodies upstream of the Delta. Any changes in DOC levels in water bodies upstream of the Delta under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies.

Delta

Under Alternative 2D, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be less extensive, and the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be similar to, or lower than, the changes described for Alternative 4. The effects of Alternative 2D relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action

Alternative (ELT), Alternative 2D would result in small increases in long-term average DOC concentrations for both the modeled 16-year period (1976–1991) and drought period (1987–1991) at several interior Delta locations (increases up to 0.3 mg/L at the S. Fork Mokelumne River at Staten Island, Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1) (Appendix 8K, *Organic Carbon*, Table DOC-12). The increases in average DOC concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at the Contra Costa Pumping Plant #1 associated with the 3 mg/L threshold (i.e., increase from 52% under Existing Conditions to 68% under Alternative 2D for the modeled 16-year period). The change in frequency of threshold concentration exceedances at other assessment locations would be similar or lower.

While Alternative 2D would lead to slightly higher long-term average DOC concentrations at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. As discussed for Alternative 4, substantial changes in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 2D are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Relative to Existing Conditions and the No Action Alternative (ELT and LLT), Alternative 2D would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below).

SWP/CVP Export Service Areas

Under the Alternative 2D, long-term average DOC concentrations would decrease at Barker Slough by 0.1 mg/L, and at both the Banks and Jones pumping plants by 0.5 mg/L, relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (ELT) (Appendix 8K, *Organic Carbon*, Table DOC-12). Decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedances of the 3 mg/L threshold during the modeled drought period would increase at the Banks and Jones pumping plants. Relative to Existing Conditions, exceedance of the 3 mg/L threshold would increase from 57% to 73% at Banks pumping plant and from 72% to 88% at Jones pumping plant. There would be little to no increase in exceedance of the 3 mg/L threshold relative to the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Maintenance of SWP and CVP facilities under Alternative 2D would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area.

NEPA Effects: In summary, the operations and maintenance activities under Alternative 2D, relative to the No Action Alternative (ELT and LLT), would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. The long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations are predicted to increase by as much as 0.3 mg/L. However, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. Based on these findings, the effect of operations and maintenance activities on DOC under Alternative 2D is determined to be not adverse.

CEQA Conclusion: For the same reasons described for Alternative 4, the operations and maintenance activities under Alternative 2D, relative to the Existing Conditions, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. Any modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DOC levels upstream of the Delta. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 2D would result in relatively small increases (i.e., ≤0.3 mg/L) in long-term average DOC concentrations at some interior Delta locations. The predicted increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. Because this alternative would lead to only slightly higher long-term average DOC concentrations at the interior Delta locations and some municipal water intakes, the predicted changes would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

Relative to Existing Conditions, Alternative 2D would result in reduced long-term average DOC concentrations at the Banks and Jones pumping plants and Barker Slough. However, Alternative 2D would result in slightly greater frequency of exceedance of the 3 mg/L DOC concentration threshold during the modeled drought period. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Alternative 2D would not result in any substantial change in long-term average DOC concentration. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Relative to existing habitat and that to be developed under the No Action Alternative (ELT and LLT), the area of new habitat restoration implemented for the Environmental Commitments would be very small. Implementation of non-habitat restoration Environmental Commitments would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, any increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Based on these findings, the effect of the Environmental Commitments on DOC is determined to be not adverse.

CEQA Conclusion: Implementation of habitat restoration (i.e., Environmental Commitments 4, 6, 7, and 10), relative to the Existing Conditions, is not expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas, because the land area proposed for restoration would be relatively small compared to existing land area and sources of DOC. Implementation of other Environmental Commitments also would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 2D on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). As described for Alternative 4, pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers. Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows and that pathogen concentrations in the rivers have a minimal relationship to river flow rate, river flow rate and reservoir storage reductions that would occur under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and

LLT), would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta.

The effects of Alternative 2D relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed. However, as described for Alternative 4, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens, because it is expected that pathogen sources in close proximity to Delta sites would have a greater influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

As such, Alternative 2D would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

NEPA Effects: Because pathogen levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on pathogens from implementing Alternative 2D are determined to be not adverse.

CEQA Conclusion: The effects of Alternative 2D on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because the factors that would affect pathogen levels in the surface waters of these areas would be similar. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. This could result in localized increases in wildlife-related coliforms relative to the No Action Alternative (ELT and LLT). The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. The remaining Environmental Commitments would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources. Based on these findings, the effects on pathogens from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of Environmental Commitments 3, 4, and 6–11 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, the Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 2D operations and maintenance on pesticide levels in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT), would be similar to those expected to occur under Alternative 4 (see Section 8.3.3.9). This is because under Alternative 2D, the primary factor that would influence pesticide concentrations in surface waters upstream of the Delta—the effect of timing and magnitude of reservoir releases on dilution capacity—is expected to change by a similar degree. Changes in average winter and summer flow rates, relative to Existing Conditions and the No Action Alternative (ELT), are expected to be similar to or less than changes in flow rates expected under Alternative 4 in the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis (Appendix 8L, *Pesticides,* Tables 1 through 4). Similarly, the primary factor that would influence pesticide concentrations in surface waters of the Delta and in the SWP/CVP Export Service Areas (i.e., changes in San Joaquin River, Sacramento River and Delta Agriculture source water fractions at various Delta locations, including Banks and Jones pumping plants) is expected to change by a similar degree. The percentage change in monthly average source water fractions would be similar to changes expected under Alternative 4 (Appendix 8D, *Source Water Fingerprinting Results*).

It was concluded for Alternative 4, and thus for Alternative 2D based on similar flow changes, that the potential average summer flow reductions would not be of sufficient magnitude to substantially increase in-river pesticide concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses upstream of the Delta. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered. Similarly, the modeled changes in the source water fractions of Sacramento River, San Joaquin River, and Delta agriculture water under Alternative 2D would not be of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of organophosphate insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

The flow changes in the LLT would be expected in the ranges of that described above for Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT), and that described for Alternative 4 relative to the No Action Alternative (LLT) in Section 8.3.3.9. Thus, similar to above and Alternative 4, the flow changes that would occur in the LLT under Alternative 2D, relative to Existing Conditions and the No Action Alternative (LLT), would not be expected to result in changes in dilution of pesticides of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses upstream of the Delta, in the Delta, or the SWP/CVP Export Service Areas.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers under Alternative 2D relative to the No Action Alternative (ELT and LLT) would be of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, changes in source water fractions to the Delta would be of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP Export Service Areas. Therefore, the effects on pesticides from the water conveyance facilities are determined not to be adverse.

***CEQA Conclusion*:** Based on the discussion above, the effects of Alternative 2D on pesticide levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or slightly less than those described for the Alternative 4. Alternative 2D would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous CWA Section 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under Alternative 2D would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly. Therefore, relative to the No Action Alternative (ELT), the effects on pesticides from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly, such that pesticide levels would differ little from Existing Conditions. Therefore, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increase in pesticide concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas. As such, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pesticide concentrations are not expected to increase substantially, no long-term water quality degradation for pesticides is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term pesticide concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. Environmental Commitments 3, 4, 6–12, 15, 16 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the Environmental Commitments propose the use of any pesticide currently named in a CWA Section 303(d) listing of the affected environment. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 2D on phosphorus concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors which affect phosphorus concentrations in surface waters of these areas are the same under Alternative 4 and Alternative 2D. As described for Alternative 4, phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under Alternative 2D, relative to Existing Conditions or the No Action Alternative (ELT), upstream of the Delta. Phosphorus concentrations may increase during January through March at locations in the Delta where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. However, based on the DSM2 fingerprinting results (Figures 331 through 352 in Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations (in Figure 8-56), the magnitude of increases during these months is expected to be negligible to low (i.e., <0.02 mg/L) at all Delta locations relative to Existing Conditions and the No Action Alternative (ELT and LLT). Thus, phosphorus concentrations in the Delta and waters exported from Banks and Jones pumping plants to the SWP/CVP Export Service Areas are expected to be similar to Existing Conditions and the No Action Alternative (ELT and LLT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on phosphorus in the LLT are expected to be similar to those described above.

NEPA Effects: In summary, operation of the water conveyance facilities would have little to no effect on phosphorus concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas, relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on phosphorus are considered to be not adverse.

CEQA Conclusion**:** The effects of Alternative 2D on phosphorus levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the Alternative 4. There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 2D relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects**:** Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, relative to the No Action Alternative (ELT and LLT), the effects on phosphorus from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the SWP/CVP Export Service Areas due to implementation of these Environmental Commitments relative to Existing Conditions. Because phosphorus concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and, thus, the Environmental Commitments would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, any increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 2D on selenium concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9), because factors affecting selenium concentrations in these water bodies would be similar. Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2D, relative to Existing Conditions or the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta. Similarly, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under Alternative 2D, given the relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Alternative 2D would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative (ELT) at all modeled Delta assessment locations (Appendix 8M, *Selenium,* Table M-33). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.04 μg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (4% or less) in available assimilative capacity for selenium, relative to USEPA's draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-45). The long-term average selenium concentrations in water under Alternative 2D (range 0.09–0.40 μg/L) would be similar to Existing Conditions (range 0.09–0.41 μg/L) and the No Action Alternative (ELT) (range 0.09–0.39 μg/L), and would be below the draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 2D would result in small changes (about 1% or less) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Appendix 8M, *Selenium,* Tables M-35 and M-39). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0, indicating low probability of adverse effects. Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 19% relative to Existing Conditions in all years (from about 4.7 to about 5.6 mg/kg dry weight) and by about 16% relative to the No Action Alternative (ELT) in all years (from 4.8 to about 5.6 mg/kg dry weight). For sturgeon in the Sacramento River at Mallard Island concentrations are predicted to increase by about 14% relative to Existing Conditions in all years (from about 4.4 to 5.0 mg/kg dry weight) and by about 11% relative to the No Action Alternative in all years (from about 4.5 to 5.0 mg/kg dry weight) (Appendix 8M, Tables M-41 and M-42). Selenium concentrations in sturgeon during drought years are expected to increase by about 2–7% at those locations (from about 6.8 to 7.3 mg/kg dry weight) (Appendix 8M, Tables M-41 and M-42). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative (ELT)) and for all years in the San Joaquin River at Antioch (where quotient increases from 0.94 to 1.0) (Appendix 8M, Table M-43). The High Toxicity Threshold Quotient would be less than 1.0 at both locations for all years and drought years (Appendix 8M, Table M-43).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in Appendix 8M, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium. Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Residence time of water in the Delta is expected to increase relative to Existing Conditions primarily as a result of habitat restoration (8,000 acres of tidal habitat restoration and enhancements to the Yolo Bypass) that is assumed to occur under the No Action Alternative (ELT) separate from Alternative 2D. Although estimates of the residence time increases are not available for Alternative 2D, estimates for Alternative 2 at the LLT (presented in Table 8-60a in Section 8.3.1.7 in the *Microcystis* subsection) which contained 65,000 acres of tidal restoration are available, and is expected that residence time increases under Alternative 2D would be substantially less than identified for Alternative 2 in the table.

If increases in fish tissue or bird egg selenium were to occur as a result of increased residence time, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. Thus, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time would be a concern is the western Delta and Suisun Bay for sturgeon. Based on the expected minor increases in residence time in the western Delta, any increases are not expected to be of sufficient magnitude to substantially affect selenium bioaccumulation.

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 2D would result in essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 2D would not be expected to substantially increase the frequency with which the applicable water quality criterion or toxicity and level of concern benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or to substantially degrade the quality of water in the Delta, with regard to selenium.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Alternative 2D would result in small (0.01–0.10 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative (ELT), for the entire period modeled (Appendix 8M, *Selenium,* Table M-33). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants, relative to the USEPA's draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-45). The long-term average selenium concentrations in water for Alternative 2D (range 0.14–0.20 μg/L) would be well below the draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 2D would result in small changes (about 1% or less) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, *Selenium,* Table M-39). Concentrations in biota would not exceed any selenium toxicity or level of concern benchmarks for Alternative 2D (Appendix 8M, Table M-39).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

NEPA Effects: Relative to the No Action Alternative (ELT and LLT), Alternative 2D would result in essentially negligible changes in selenium concentrations in water upstream of the Delta. Similarly, there would be negligible changes in selenium water and most biota concentrations in the Delta, with no exceedances of benchmarks for biological effects. For sturgeon in the Delta, there would be only a small increase of threshold exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark. At the Banks and Jones pumping plants, Alternative 2D would cause no increases in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations. Therefore, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 2D are considered to be not adverse.

CEQA Conclusion: There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate Alternative 2D would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.0 for Alternative 2D. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 2D would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 2D would cause no increases in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 2D would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under Alternative 2D would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to the No Action Alternative (ELT and LLT). Therefore, the effects on selenium from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to Existing Conditions. Therefore, it is expected that with implementation of these Environmental Commitments there would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the SWP/CVP Export Service Areas, relative to Existing Conditions. As such, these Environmental Commitments would not contribute to additional exceedances of applicable water quality objectives/criteria. Given the factors discussed in the assessment above and for Alternative 4 (see Section 8.3.3.9), any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, these Environmental Commitments would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a CWA Section 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see BDCP Appendix 3.C, *Avoidance and Minimization Measures*, for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 2D on trace metal concentrations in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be similar to those effects described for Alternative 4 (see Section 8.3.3.9).

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta.

In the Delta, for metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, and very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based (see Tables 8-51 and 8-52 in Section 8.3.1.7, *Construction-Specific Considerations Used in the Assessment*). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur. For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar (see Tables 8–10 in Appendix 8N,*Trace Metals*) and average concentrations are below human health criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur.

Because Alternative 2D would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP Export Service Areas, relative to Existing Conditions or the No Action Alternative (ELT and LLT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on trace metals in the LLT are expected to be similar to those described above.

As such, Alternative 2D would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: Alternative 2D would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals, relative to the No Action Alternative (ELT and LLT). Therefore, the effects on trace metals from implementing Alternative 2D are determined to not be adverse.

CEQA Conclusion: While Alternative 2D would alter the magnitude and timing of reservoir releases north, south and east of the Delta, this would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under Alternative 2D.

Because Alternative 2D is not expected to result in substantial changes in trace metal concentrations in Delta waters, which includes Banks and Jones pumping plants, effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Because Environmental Commitments 3, 4, 6–12, 15, and 16 present no new sources of trace metals to the affected environment, the effects on trace metal concentrations from implementing these Environmental Commitments are determined to be not adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas, because they present no new sources of trace metals to the affected environment. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

As described for Alternative 4 (see Section 8.3.3.9), the operation of the water conveyance facilities under Alternative 2D is expected to have a minimal effect on TSS and turbidity levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions and the No Action Alternative (ELT and LLT). This is because the factors that would affect TSS and turbidity levels in the surface waters of these areas would be the same. TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water. Within the Delta, TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of inflows (and associated sediment load), as well as fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water. These factors would be similar under Alternative 2D and Alternative 4, are expected to be minimally different from Existing Conditions and the No Action Alternative (ELT and LLT). Because Alternative 2D is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative (ELT and LLT), Alternative 2D also is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

NEPA Effects: Because TSS concentrations and turbidity levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on TSS and turbidity from implementing Alternative 2D are determined to not be adverse.

CEQA Conclusion: As described for Alternative 4 (see Section 8.3.3.9) changes in river flow rate and reservoir storage that would occur under Alternative 2D, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative

2D, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Localized, temporary changes in TSS and turbidity could occur associated with the restoration actions of Environmental Commitments 3, 4, 6–12, 15, and 16. However, these changes would be gradual and not expected to substantially differ from No Action Alternative (ELT and LLT) conditions. Therefore, the effects on TSS and turbidity from implementing these Environmental Commitments are determined to be not adverse.

CEQA Conclusion: It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities for the Water Conveyance Facilities and Environmental Commitments

The potential construction-related water quality effects that would occur under Alternative 2D would be similar to the effects described for Alternative 4A (see Section 8.3.4.2). This is because the type, size and number of construction activities for water conveyance facilities and Environmental Commitments that would occur under Alternative 2D would be similar to Alternative 4A. The construction-related activities for the water conveyance facilities under Alternative 2D would be similar to those described for Alternative 4A. However, there would be more construction activity associated with two additional intakes and the area of in-water habitat restoration activities implemented under Alternative 2D would be greater.

NEPA Effects: The types and magnitude of potential construction-related water quality effects associated with implementation of Alternative 2D would be very similar to the effects discussed for Alternative 4A. Nevertheless, the construction of water conveyance facilities and Environmental Commitments, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and other agency permitted construction requirements, would result in the potential water quality effects being largely avoided and minimized. The specific Environmental Commitments that would be implemented under Alternative 2D would be similar to those described for Alternative 4A. Consequently, relative to the No Action Alternative (ELT), Alternative 2D would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. Therefore, with implementation of environmental commitments presented in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 2D for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or CWA Section 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause CWA Section 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Adverse effects from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under Alternative 2D or the No Action Alternative (ELT and LLT). Consequently, any modified reservoir operations under Alternative 2D are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT).

Delta

During the June through October period when *Microcystis* blooms occur in the Delta, it is a combination of flows, associated residence time, and water temperatures that are believed to most influence *Microcystis* bloom formation.

Under Alternative 2D, a portion of the Sacramento River water which is conveyed through the Delta to the south Delta intakes under Existing Conditions would be replaced at various locations throughout the Delta by other source water due to diversion of Sacramento River water at the north Delta intakes. The changes in flow paths of water through the Delta and change in operation of the south Delta pumps that would occur due to facilities operations and maintenance of Alternative 2D could result in localized increases in residence time in various Delta sub-regions and decreases in residence time in other areas. Because there is no published analysis of the relationship between *Microcystis* occurrence and residence time, there is uncertainty on how increased residence times may affect *Microcystis* occurrences (ICF International 2016). Further, there is substantial uncertainty regarding the extent that facilities operations and maintenance of Alternative 2D would result in a net increase in water residence times at various locations throughout the Delta, relative to Existing Conditions. In addition to the effects of operations and maintenance of Alternative 2D, increases in water residence times are expected occur due to separate factors and actions concurrent with the alternative, including habitat restoration (8,000 acres of tidal habitat and enhancements in the Yolo Bypass) and sea level rise due to climate change.

To ensure project operations do not create increased *Microcystis* blooms in the Delta, water flow through Delta channels can be managed through real-time operations, particularly the balancing of the north and south Delta diversions. By operating the south Delta pumps more frequently during periods conducive to increased *Microcystis* blooms, residence times can be managed to decrease the potential for blooms to develop, and thus decrease potential microcystin increases due to project operations. As such, effects of Alternative 2D on *Microcystis* levels, and thus microcystin concentrations in the Delta, would not be made more adverse relative to Existing Conditions and the No Action Alternative (ELT and LLT).

Water temperature is also a critical parameter that has been related to *Microcystis* blooms in the Delta. Since Delta water temperatures are largely driven by air temperature, climate change that increases air temperatures relative to Existing Conditions would be expected to increase ambient water temperatures in the Delta by 1.3–2.5°F. These climate changes in the ELT are expected to occur in the Delta under the No Action Alternative, relative to Existing Conditions. Alternative 2D operations and maintenance is not expected to cause increased Delta water temperatures, relative to Existing Conditions or the No Action Alternative.

In summary, increased frequency and magnitude of *Microcystis* blooms may occur in the Delta in the future, relative to Existing Conditions, due to factors unrelated to the project alternative, including: 1) increased residence times resulting from restoration activities and climate change-related sea level rise and 2) climate change-related increased Delta water temperatures. If *Microcystis* occurrences did increase in certain sub-regions of the Delta in the future, there would also be the potential for increased microcystin presence in the Delta, relative to Existing Conditions. To ensure project operations under Alternative 2D do not create significant increases in *Microcystis* blooms in the Delta, that may be associated with increased residence times, water flow through Delta channels would be managed through real-time operations.

SWP/CVP Export Service Area

As described above for the Delta, source waters to the south Delta intakes could be adversely affected, relative to Existing Conditions by *Microcystis* both from an increase in Delta water temperatures associated with climate change and from an increase in water residence times. The impacts from increased Delta water residence times would be primarily related to habitat restoration (8,000 acres of tidal habitat restoration and enhancements in the Yolo Bypass) that is assumed to occur separate from Alternative 2D. The combined effect of these factors on the potential for *Microcystis* blooms in source waters to the south Delta intakes is expected to be much greater than the influence of operations and maintenance of Alternative 2D, the effects of which will be mitigated through real time operations. Increases in ambient air temperatures due to climate change relative to Existing Conditions are expected under this alternative. Increases in ambient air temperatures are expected to result in warmer ambient water temperatures, and thus conditions more suitable to *Microcystis* growth, in the water bodies of the SWP/CVP Export Service Areas. The incremental increase in long-term average air temperatures would be less at the ELT (2.0°F), compared to the LLT (4.0°F).

As discussed in the Delta section above, Alternative 2D is not expected to substantially adversely affect *Microcystis* blooms, relative to Existing Conditions and the No Action Alternative (ELT and LLT). Additionally, residence time and water temperature conditions in the SWP/CVP Export Service Areas are not expected to become more conducive to *Microcystis* bloom formation due to the operations and maintenance of Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT), because water residence times are not projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change not due to Alternative 2D.

NEPA Effects: Modified reservoir operations under Alternative 2D are not expected to promote *Microcystis* production upstream of the Delta, relative to the No Action Alternative (ELT and LLT). Similarly, operations and maintenance of Alternative 2D is not expected to substantially increase water residence times or ambient water temperatures in the Delta, including at the Banks and Jones pumping plants, and thus is not expected to result in adverse effects on *Microcystis* in the Delta, relative to No Action Alternative (ELT and LLT). Lack of adverse effects on *Microcystis* in the Delta would mean that Delta waters diverted into the SWP/CVP Export Service Areas would not be adversely affected. Finally, the potential for *Microcystis* bloom formation within the SWP/CVP Export Service Area water bodies and canals would not be expected to change substantially, if at all, because water residence times are not projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change and not due to Alternative 2D. Thus, the effects on *Microcystis* in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas from implementing Alternative 2D are determined to be not adverse.

CEQA Conclusion: Modified reservoir operations under Alternative 2D are not expected to promote *Microcystis* production upstream of the Delta, relative to the Existing Conditions. Increased frequency and magnitude of *Microcystis* blooms may occur in the Delta in the future, relative to Existing Conditions, due to increased residence times resulting from restoration activities unrelated to the project alternative, as well as climate change and sea level rise that are expected to increase Delta water temperatures. Such increases in residence time and water temperatures would not be caused by implementation of Alternative 2D. Operations and maintenance of Alternative 2D, including the use of real-time operations, are not expected to result in flow and temperature conditions in the Delta, including at the Banks and Jones pumping plants, that would cause substantial increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas of the Delta would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Microcystin, the toxin produced by *Microcystis,* is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences due to climate change and sea level rise may lead to increased microcystin presence in the Delta, relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation related to microcystin levels may occur and, thus, impacts on beneficial uses could occur, these impacts are not related to implementation of Alternative 2D. Although there is uncertainty regarding this impact, the effects on *Microcystis* from implementing water conveyance facilities are determined to be less than significant. No mitigation is required.

Impact WQ-33: Effects on *Microcystis* Bloom Formation Resulting from Environmental Commitments

Effects on *Microcystis* from implementation of Environmental Commitments under Alternative 2D would be the same as those described for Alternative 4A.

NEPA Effects: Based on the discussion for Impact WQ-33 in Section 8.3.4.2, the effects on *Microcystis* from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusions: Based on the discussion for Impact WQ-33 in Section 8.3.4.2, Environmental Commitments 3, 4, 6–12, 15, and 16 would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta would occur at the early long-term for reasons unassociated with implementation of the Environmental Commitments, including tidal habitat restoration. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation related to microcystins levels may occur and, thus, significant impacts on beneficial uses could occur, these impacts are not related to implementation of the Environmental Commitments. Therefore, the effects on *Microcystis* from implementing the Environmental Commitments are determined to be less than significant. No mitigation is required.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance and Environmental Commitments

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 2D would have a less-than-significant impact/no adverse effect on the following constituents in the Delta:

- Boron

- Bromide
- Chloride
- DOC
- DO
- Pathogens
- Pesticides
- Trace metals
- Turbidity and TSS
- *Microcystis*

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. Chloride, DOC, and bromide concentrations also are of concern in drinking water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, trace metals, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Changes in *Microcystis* would be primarily due to factors unassociated with the project alternative. Thus, changes in boron, bromide, chloride, DOC, DO, pathogens, pesticides, trace metals, turbidity and TSS, and *Microcystis* in Delta outflow associated with implementation of Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT) are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay, as described for Alternative 4 (see Section 8.3.3.9).

Elevated EC is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. San Francisco Bay does not have an AGR beneficial use designation. As described for Alternative 4, salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. However, the changes in Delta outflow due to Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Also, as described for Alternative 4, changes in nutrient loading would not be expected to contribute to adverse effects to beneficial uses. Changes in nitrogen (ammonia and nitrate) loading to Suisun and San Pablo Bays under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay. The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. As described for Alternative 4, any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary. Therefore, changes in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay, relative to Existing Conditions and the No Action Alternative (ELT and LLT), shown in Appendix 8O, *San Francisco Bay Analysis*, Table 8O-1, are not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Similar to Alternative 4, loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 2D, relative to Existing Conditions and the No Action Alternative (ELT and LLT) (Appendix 8O, *San Francisco Bay Analysis*, Table 8O-2). Also, the incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 μg/L) under this alternative (Appendix 8O, Table 8O-3).

NEPA Effects: Based on the discussion above, Alternative 2D, relative to the No Action Alternative (ELT and LLT), would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, turbidity and TSS, or *Microcystis* in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, effects on the San Francisco Bay from implementation of water conveyance facilities and Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: As with Alternative 4, Alternative 2D would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals, turbidity or TSS, and *Microcystis* are anticipated in the Delta due to the implementation of Alternative 2D, relative to Existing Conditions, therefore, no substantial changes to these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow and thus, have minimal influence on salinity changes. Changes in nutrient load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. As with Alternative 4, the change in mercury and methylmercury load (which is based on source water and Delta outflow), relative to Existing Conditions, would be within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Similarly, based on Alternative 4 estimates, the increase in selenium load would be minimal, and total and dissolved selenium concentrations would be expected to be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the change in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

8.3.4.4 Alternative 5A—Dual Conveyance with Modified Pipeline/Tunnel and Intake 2 (3,000 cfs; Operational Scenario C)

Discussion of water quality impacts of Alternative 5A was first provided in the RDEIR/SDEIS. The water quality assessments in the RDEIR/SDEIS for boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Services Areas utilized results from water quality modeling performed for Alternative 5 in the ELT, which included Yolo Bypass improvements, 25,000 acres of tidal habitat restoration, and the EC compliance location at Emmaton relocated to Threemile Slough. The analysis of effects of Alternative 5A, presented herein, on boron, bromide, chloride, DOC, EC, mercury, nitrate, and selenium in the Delta and SWP/CVP Export Service Areas is based on revised modeling, which assumed implementation of Yolo Bypass improvements, the EC compliance location remaining at Emmaton, and no tidal habitat restoration. Because the modeling of Alternative 5A and the No Action Alternative (ELT) included Yolo Bypass Improvements, but no tidal habitat restoration, comparison of modeling results for Alternative 5A to No Action Alternative (ELT) results in the impact discussions below allows for isolating and identifying effects solely due to implementation of Alternative 5A in the ELT.

As described in Chapter 3, *Description of Alternatives*, actions associated with Alternative 4 that are not proposed to be implemented under Alternative 5A would continue to be pursued as part of existing, but separate, projects and programs associated with the 2008 USFWS and 2009 NMFS BiOps, California EcoRestore, and the 2014 California Water Action Plan. Due to the reduced suite of Environmental Commitments in Alternative 5A compared to Alternative 4 (in particular, significantly less tidal habitat restoration), the impacts to water quality due to Alternative 5A are substantially less compared to Alternative 4, particularly in the Delta.

The water quality impact conclusions for Alternative 5A remain the same as those presented in the RDEIR/SDEIS. The revisions to the assessment are in the presentation of modeled changes in concentrations, water quality criteria/objective exceedances, and use of assimilative capacity, and refinements to mitigation measures for EC.

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), substantial point and non-point sources of ammonia-N do not exist upstream of the SRWTP at Freeport in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Thus, like Alternative 4, operation of the water conveyance facilities under Alternative 5A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT and LLT). Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As described for Alternative 4 (see Section 8.3.3.9), a substantial decrease in Sacramento River ammonia concentrations is expected under Alternative 5A relative to Existing Conditions, due to planned lowering of ammonia in the SRWTP effluent discharge, and this is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Concentrations of ammonia at locations not influenced notably by Sacramento River water would change little relative to Existing Conditions, due to the similarity in San Joaquin River and San Francisco Bay concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 5A would not result in substantial increases in ammonia concentrations in the project area, relative to Existing Conditions.

Relative to the No Action Alternative (ELT and LLT), the primary mechanism that could potentially alter ammonia concentrations under Alternative 5A is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This flow change would be attributable only to operations of the water conveyance facilities, since the same assumptions regarding SRWTP discharge ammonia concentrations, water demands, climate change, and sea level rise apply to both Alternative 5A and the No Action Alternative (ELT and LLT). A simple mass balance calculation was performed to calculate ammonia concentrations downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 5A and the No Action Alternative (ELT) to assess the effects of the flow changes. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia limitations (1.5 mg/L-N in Apr–Oct, 2.4 mg/L-N in Nov–Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-75 shows monthly average and long-term annual average predicted concentrations under Alternative 5A. As Table 8-75 shows, average monthly ammonia concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 5A and the No Action Alternative (ELT) are expected to be similar. In comparison to the No Action Alternative (ELT), minor increases in monthly average ammonia concentrations would occur during August, September, and November under Alternative 5A. Minor decreases in ammonia concentrations are expected for Alternative 5A in January through April, June and December. The annual average concentration under Alternative 5A would be the same as that under the No Action Alternative (ELT). Relative to the No Action Alternative (LLT), Alternative 5A (LLT) is expected to result in similar minor increases in Sacramento River ammonia concentration, because the increased water demands, climate change, and sea level rise in the LLT would occur under both alternatives, and neither would affect ammonia sources or loading. The estimated ammonia concentrations in the Sacramento River downstream of Freeport under Alternative 5A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 5A, relative to the No Action Alternative (ELT and LLT), are not expected to substantially increase ammonia concentrations at any Delta locations.

Ammonia concentrations downstream of Freeport on the Sacramento River under Alternative 5A would be similar to those under Alternative 4 (see Table 8-67 in Section 8.3.3.9). As stated for Alternative 4, any negligible increases in ammonia concentrations that could occur at certain locations in the Delta under Alternative 5A would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to ammonia.

Table 8-75. Estimated Ammonia (mg/L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative Early Long-Term Timeframe (ELT) and Alternative 5A

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative (ELT)	0.076	0.082	0.069	0.062	0.059	0.062	0.059	0.062	0.067	0.060	0.067	0.064	0.066
Alternative 5A	0.076	0.085	0.068	0.061	0.058	0.061	0.058	0.062	0.064	0.060	0.068	0.068	0.066

SWP CVP Export Service Areas

As discussed above, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 5A, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). Like Alternative 4, this decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regard to ammonia. Furthermore, as discussed above, for all areas of the Delta, including Banks and Jones pumping plants, ammonia concentrations are not expected to be substantially different under Alternative 5A (LLT) relative to the No Action Alternative (ELT), and Alternative 5A (LLT) relative to the No Action Alternative (LLT). Thus, any negligible increases in ammonia concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade water quality at these locations, with regard to ammonia.

NEPA Effects: In summary, ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas are not expected to be substantially different under Alternative 5A relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on ammonia are considered to be not adverse.

CEQA Conclusion: The magnitude and direction of changes in ammonia concentrations in water bodies upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas would be approximately the same as expected under Alternative 4, relative to Existing Conditions. There would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 5A relative to Existing Conditions. As such, Alternative 5A is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect ammonia sources or loading. Based on these findings, the effects on ammonia from the implementation Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 5A are determined to not be adverse.

CEQA Conclusion**:** Land use changes that would occur from the Environmental Commitments are not expected to contribute substantially increase ammonia concentrations, because the amount of area to be converted would be small relative to existing habitat, and any resulting ammonia would likely be rapidly converted to nitrate. Thus, there would be no substantial, long-term increase in ammonia concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. As such, implementation of these Environmental Commitments would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these Environmental Commitments, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not CWA Section 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 5A there would be no expected change to the sources of boron in the Sacramento River and eastside tributary watersheds and, thus, resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease by 1%, relative to Existing Conditions (in association with the different operational components of Alternative 5A in the ELT, climate change, and increased water demands) (Appendix 8F, *Boron*, Table Bo-32). The reduced flow relative to Existing Conditions would result in possible increases in long-term average boron concentrations of up to about 0.5% relative to the Existing Conditions. Flows would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial boron increases relative to the No Action Alternative (ELT). The increased boron concentrations, relative to Existing Conditions, under Alternative 5A in the ELT would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 5A in the ELT would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 5A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect boron sources in these areas.

Delta

Effects of water conveyance facilities on boron under Alternative 5A in the Delta would be similar to the effects discussed for Alternative 4.

The effects of Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action Alternative (ELT), Alternative 5A would result in increased long-term average boron concentrations for the 16-year period modeled at most of the interior Delta locations (increases up to 1% at the S. Fork Mokelumne River at Staten Island, 3% at Franks Tract, and 4% at Old River at Rock Slough) (Appendix 8F, *Boron*, Table Bo-30). The long-term average boron concentrations at most of the western Delta assessment locations would not change measurably. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or the 500 μg/L agricultural objective at the majority of assessment locations, which represents no change from the Existing Conditions and No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-3C). A small increase in the frequency of exceedances 500 μg/L agricultural objective at the Sacramento River at Mallard Island (i.e., as much as 5% in the drought period relative to the No Action Alternative [ELT]) would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. Minor reductions in long-term average assimilative capacity of up to 2% at interior Delta locations (i.e., Old River at Rock Slough) would occur with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-31). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 5A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, *Boron*, Figure Bo-6).

Effects of Alternative 5A in the Delta in the LLT, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to those described above for the ELT. Boron concentrations may be higher at western Delta locations due to greater effects of climate change on sea level rise that would occur in the LLT; however, these effects are independent of the alternative.

Further, boron is of concern in waters diverted for agricultural use, which primarily occurs in the interior Delta, and based on Delta source water characteristics (see Table 8-42 in Section 8.3.1.7, *Construction-Specific Considerations Used in the Assessment*), boron concentrations in the interior Delta would be expected to remain suitable for agricultural use.

SWP/CVP Export Service Areas

Under the Alternative 5A, long-term average boron concentrations would decrease at Banks pumping plant (13%) and Jones pumping plant (11%) relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (ELT) (Appendix 8F, *Boron*, Table Bo-30) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing CWA Section 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading. These same effects on boron at the Banks and Jones pumping plants would be expected in the LLT, because the primary effect of climate change on sea level rise and boron concentrations is expected in the western Delta.

Maintenance of SWP and CVP facilities under Alternative 5A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative (ELT and LLT), Alternative 5A would result in relatively small increases in long-term average boron concentrations in the Delta, not measurably increase boron levels in the lower San Joaquin River, and reduce boron levels in water exported to the SWP/CVP export service areas. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Based on the above assessment, any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels upstream of the Delta. Small increases in boron levels predicted for interior Delta locations in response to a shift in the Delta source water percentages would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 5A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 5A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 5A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing CWA Section 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 5A present no new direct sources of boron to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. Habitat restoration activities in the Delta, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative (ELT and LLT). Consequently, as they pertain to boron, implementation of the Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 for Alternative 5A would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. As such, their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (see Section 8.3.3.9), under Alternative 5A in the ELT there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Thus, changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial bromide increases (Appendix 8E, *Bromide*, Table 24). Moreover, there are no existing municipal intakes on the lower San Joaquin River, which is the beneficial use most sensitive to elevated bromide concentrations. Consequently, Alternative 5A in the ELT would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the San Joaquin River, the eastside tributaries, or their associated reservoirs upstream of the Delta due to changes in bromide concentrations.

Effects of Alternative 5A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect bromide sources in these areas.

Delta

Estimates of bromide concentrations at Delta assessment locations were generated using a mass balance approach, and using relationships between EC and chloride and between chloride and bromide and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in bromide at Delta assessment locations based on both approaches.

Based on the mass balance modeling approach for bromide, relative to Existing Conditions, Alternative 5A long-term average bromide concentrations would increase in the S. Fork Mokelumne River at Staten Island and Sacramento River at Emmaton, and decrease at all other assessment locations (Appendix 8E, *Bromide*, Table 22). Average bromide concentrations at Staten Island would increase from 50 µg/L under Existing Conditions to 52 µg/L (4% increase), and at Sacramento River at Emmaton from 1,284 µg/L to 1,286 µg/L (<1% increase) for the modeled 16-year hydrologic period (1976–1991). However, multiple interior and western Delta assessment locations would have an increased frequency of exceedance of 50 µg/L, which is the CALFED Drinking Water Program goal for bromide as a long-term average applied to drinking water intakes (Appendix 8E, Table 22). These locations are the S. Fork Mokelumne River at Staten Island, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. The greatest increase in frequency of exceedance of the CALFED Drinking Water Program long-term goal of 50 µg/L would occur in the S. Fork Mokelumne River (7% increase) and Sacramento River at Emmaton (3% increase). The increase in frequency of exceedance of the 50 µg/L threshold at the other locations would be 3% or less. Also, these locations (with the exception of the S. Fork Mokelumne River) and the Franks Tract and Contra Costa Pumping Plant #1 locations would have an increased frequency of exceedance of 100 µg/L, which is the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts (Appendix 8E, Table 22). The greatest increase in frequency of exceedance of 100 µg/L would occur at Sacramento River at Emmaton (4% increase). The increase in frequency of exceedance of the 100 µg/L threshold at the other locations would be 3% or less.

Changes in long-term average bromide concentrations and changes in threshold exceedance frequencies relative to the No Action Alternative (ELT) are generally of similar magnitude to those previously described relative to Existing Conditions (Appendix 8E, *Bromide*, Table 22). However, there would not be an increased frequency of exceedance of the 50 µg/L threshold in Old River at Rock Slough, but in Barker Slough there would be a 1% increase relative to the No Action Alternative (ELT). There would not be an increased frequency of exceedance of the 100 µg/L threshold at the Sacramento River at Emmaton and Mallard Island. The frequency of exceedance of the 100 µg/L threshold would increase by 2% at Contra Costa Pumping Plant #1 and 1% at Franks Tract, Old River at Rock Slough, and the San Joaquin River at Antioch.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide were consistent with the discussion above, and assessment of bromide using these modeling results lead to the same conclusions as are presented above for the mass balance approach (Appendix 8E, Table 23).

Unlike Alternative 4, there would be no increased bromide concentration in Barker Slough at the North Bay Aqueduct under Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT). Also, the magnitude of bromide concentration changes at Mallard Slough and in the San Joaquin River at Antioch during their historical months of use, relative to Existing Conditions and the No Action Alternative (ELT), would be generally similar to those described for Alternative 4 (Appendix 8E, *Bromide*, Table 25), and the frequency of exceedance of bromide thresholds would be similar (Appendix 8E, Table 22). As described for Alternative 4, the use of seasonal intakes at these locations is largely driven by acceptable water quality, and thus has historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at Antioch and Mallard Slough would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The effects of Alternative 5A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above. There may be higher bromide concentrations in the LLT in the western Delta, but this would be associated with sea level rise, not the project alternative, because the primary source of bromide to the Delta is sea water intrusion.

SWP/CVP Export Service Areas

Under Alternative 5A, long-term average bromide concentrations at the Banks and Jones pumping plants, based on the mass balance modeling approach, would decrease. Long-term average bromide concentrations for the modeled 16-year hydrologic period at the pumping plants would decrease by as much as 30% relative to Existing Conditions and 21% relative to the No Action Alternative (ELT) (Appendix 8E, *Bromide*, Table 22). As a result, less frequent exceedances of the 50 μg/L and 100 μg/L assessment thresholds would occur and an overall improvement in SWP/CVP Export Service Areas water quality would occur respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also occur since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide are consistent with the mass balance results, and assessment of bromide using these modeling results leads to the same conclusions (Appendix 8E, Table 23).

The effects of Alternative 5A in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to that described above, because the sea level rise that could occur in the LLT would not result in substantial bromide contributions to the water exported at Banks and Jones pumping plants.

Maintenance of SWP and CVP facilities under Alternative 5A would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, the operations and maintenance activities under Alternative 5A, relative to the No Action Alternative (ELT and LLT) would result in an increased frequency of exceedance of the CALFED Drinking Water Program long-term bromide goal of 50 μg/L at the S. Fork Mokelumne River at Staten Island, Sacramento River at Emmaton, San Joaquin River at Antioch, Sacramento River at Mallard Island, and in Barker Slough. The frequency of exceedance of the 100 μg/L threshold for protection against the formation of disinfection byproducts in treated drinking water would increase by 2% at Contra Costa Pumping Plant #1 and 1% at Franks Tract, Old River at Rock Slough, and the San Joaquin River at Antioch. However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island and Sacramento River at Emmaton; there would be decreases in long-term average bromide concentrations at the other assessment locations. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island would be less than the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts, and the increase at Emmaton would be very small (<1%). Thus, these increased bromide concentrations are not expected to result in adverse effects to MUN beneficial uses, or any other beneficial use, at these locations. Based on these findings, this effect is determined to not be adverse.

CEQA Conclusion: While greater water demands under Alternative 5A would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the San Joaquin River, the eastside tributaries, and the various reservoirs of the related watersheds, as described for Alternative 4 (see Section 8.3.3.9).

Under Alternative 5A there would be an increased frequency of exceedance of the CALFED Drinking Water Program long-term bromide goal of 50 μg/L at the S. Fork Mokelumne River at Staten Island, Old River at Rock Slough, Sacramento River at Emmaton, San Joaquin River at Antioch, and Sacramento River at Mallard Island. Also, these locations (with the exception of the S. Fork Mokelumne River) and the Franks Tract and Contra Costa Pumping Plant #1 locations, would have an increased frequency of exceedance of 100 μg/L, which is the concentration believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts. However, long-term average bromide concentrations would increase only in the S. Fork Mokelumne River at Staten Island and Sacramento River at Emmaton and decrease at all other assessment locations. The long-term bromide concentration in the S. Fork Mokelumne River at Staten Island (52 μg/L) would be less than the 100 μg/L believed to be sufficient to meet currently established drinking water criteria for disinfection byproducts, and the increase at Sacramento River at Emmaton would be very small (<1%). Further, as described for Alternative 4 (see Section 8.3.3.9), the use of seasonal intakes at Antioch and Mallard Island is largely driven by acceptable water quality, and thus has historically been opportunistic and opportunity to use these intakes would remain. Thus, these increased bromide concentrations would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Long-term average bromide concentrations at the Banks and Jones pumping plants are predicted to decrease by as much as 30% relative to Existing Conditions and there would be less frequent exceedance of bromide concentration thresholds.

Based on the above, Alternative 5A would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. Alternative 5A would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 μg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 μg/L assessment threshold concentration would be 4% or less at all locations assessed, which is considered to be less than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the Alternative 5A would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not CWA Section 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant. No mitigation is required.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Therefore, as they pertain to bromide, implementation of these Environmental Commitments would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

Environmental Commitment 4 would result in some tidal habitat restoration, however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable bromide concentration changes.

In summary, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 5A relative to the No Action Alternative (ELT and LLT), would have negligible, if any, effects on bromide concentrations. Therefore, the effects on bromide from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 5A would not present new or substantially changed sources of bromide to the affected environment. Some Environmental Commitments may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. Based on these findings, this impact is considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 5A on chloride concentrations in reservoirs and rivers upstream of the Delta would be the similar to those effects described for Alternative 4 (see Section 8.3.3.9). Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. There would be no expected change to the sources of chloride in the Sacramento River and eastside tributary watersheds, and changes in the magnitude and timing of reservoir releases north and east of the Delta would have negligible, if any, effect on the sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. The modeled annual average lower San Joaquin River flow at Vernalis would decrease slightly (1%) compared to Existing Conditions and would remain virtually the same as the No Action Alternative (ELT), and thus flow changes would not result in substantial chloride increases. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, Alternative 5A in the ELT would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Effects of Alternative 5A in reservoirs and rivers upstream of the Delta in the LLT relative to Existing Conditions and the No Action Alternative (LLT) would be expected to be similar, because the climate change and sea level rise that would occur in the LLT would not affect chloride sources in these areas.

Delta

Estimates of chloride concentrations at Delta assessment locations were generated using a mass balance approach and EC-chloride relationships and DSM2 EC output. See Section 8.3.1.3, *Plan Area*, for more information regarding these modeling approaches. The assessment below identifies changes in chloride at Delta assessment locations based on both approaches.

Modeling of chloride using both the mass balance approach and EC-chloride relationship predicts that Alternative 5A in the ELT would result in reduced long-term average chloride concentrations, relative to Existing Conditions, for the 16-year period modeled at all assessment locations except for the S. Fork Mokelumne River at Staten Island. The increase in long-term average chloride concentration at Staten Island would be 1 mg/L (3%) based on the mass balance modeling and <1 mg/L (1%) based on the EC-chloride relationship (Appendix 8G, *Chloride*, Tables Cl-77 and Cl-78). These increases are extremely small in absolute terms and relative to applicable water quality objectives, and are within the estimated modeling uncertainty. This differs from Alternative 4, under which there would be increased long-term average chloride concentrations also at the North Bay Aqueduct at Barker Slough. The change in long-term average chloride concentrations relative to the No Action Alternative (ELT) would be similar to those relative to Existing Conditions.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percentage of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at Antioch and Contra Costa Pumping Plant #1. The modeled frequency of objective exceedance would decrease at the Contra Costa Pumping Plant #1 from 7% of years under Existing Conditions to 0% of years under Alternative 5A in the ELT (Appendix 8G, *Chloride*, Table Cl-64).

Evaluation of the 250 mg/L Bay-Delta WQCP objective for chloride utilized results from both the mass balance approach and EC-chloride relationship. The basis for the evaluation was the predicted number of days the objective would be exceeded for the modeled 16-year period.

Based on the mass balance approach, there would be a decreased frequency of exceedance of the 250 mg/L objective under Alternative 5A, relative to Existing Conditions, at all locations except in the Sacramento River at Mallard Island, San Joaquin River at Antioch, and the Sacramento River at Emmaton. In the Sacramento River at Mallard Island, the frequency of objective exceedance would increase from 85% under Existing Conditions to 86% under Alternative 5A for the entire period modeled (Appendix 8G, *Chloride*, Table Cl-81). In the San Joaquin River at Antioch, there would be an increase in chloride objective exceedance for the entire period modeled, from 66% under Existing Conditions to 70% under Alternative 5A. In the Sacramento River at Emmaton, there would be an increase in chloride objective exceedance during the drought period modeled, from 55% to 57%.

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 5A, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions, to 5% of modeled days under Alternative 5A (Appendix 8G, *Chloride*, Table Cl-63).

The mass balance results also indicate reduced assimilative capacity with respect to the 250 mg/L objective during certain months and at certain locations. In the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in March and April of up to 18% for the 16-year period modeled and 52% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-79). Assimilative capacity at the Contra Costa Pumping Plant #1 also would be reduced, in February through April by up to 8%, and in January of the drought period modeled by 4%.

When utilizing the EC-chloride relationship to model chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-80 and Cl-82). However, the EC-chloride relationships generally predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

CWA Section 303(d) Listed Water Bodies–Relative to Existing Conditions

Tom Paine Slough in the southern Delta is on the state's CWA Section 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. Monthly average chloride concentrations at the Old River at Tracy Road for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine Slough, would be generally similar under Alternative 5A in the ELT relative to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, *Chloride*, Figure Cl-17).

Suisun Marsh also is on the state's CWA Section 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase by <10% under Alternative 5A in the ELT relative to Existing Conditions in March and April at the Sacramento River at Mallard Island (Appendix 8G, *Chloride*, Figure Cl-18), at Collinsville (Appendix 8G, Figure Cl-19), and in Montezuma Slough at Beldon's Landing (Appendix 8G, Figure Cl-20), and remain similar or decrease in all other months. Chloride levels in Suisun Marsh are highly dynamic on a sub-daily basis as a result of tidal influences. The changes identified above are small relative to normal day-to-day variability in chloride in Suisun Marsh. For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses. These changes reflect the effect of climate change and sea level rise, as well as the alternative. Comparisons to the No Action Alternative (ELT) below provide an assessment of the effect of the alternative alone.

Municipal Beneficial Uses Relative to No Action Alternative (ELT)

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated from EC-chloride relationships were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 5A in the ELT, the modeled frequency of objective exceedance would not change at the Contra Costa Pumping Plant #1—both the No Action Alternative (ELT) and Alternative 5A in the ELT all would have 0% exceedance (Appendix 8G, *Chloride*, Table Cl-64).

Based on the mass balance approach, the frequency of exceedance of the 250 mg/L objective under Alternative 5A in the ELT would be the same, or would decrease, at all locations relative to the No Action Alternative (ELT), except in the San Joaquin River at Antioch during the drought period modeled (Appendix 8G, *Chloride*, Table Cl-81). The frequency of objective exceedance would increase from 85% to 87% at Antioch.

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3, *Plan Area*) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1, where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 5A, the modeled frequency of objective exceedance would decrease, from 8% of modeled days under the No Action Alternative (ELT), to 5% of modeled days under Alternative 5A (Appendix 8G, *Chloride*, Table Cl-63).

The mass balance results indicate reduced assimilative capacity with respect to the 250 mg/L objective for certain months and locations. In the San Joaquin River at Antioch, there would be a reduction in assimilative capacity in April of 14% for the drought period modeled (Appendix 8G, *Chloride*, Table Cl-79).

When utilizing the EC-chloride relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to those discussed for the mass balance modeling approach (Appendix 8G, *Chloride*, Tables Cl-80 and Cl-82). However, utilizing the EC-chloride relationships generally predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, *Plan Area*, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Figure Cl-21 in Appendix 8G, *Chloride*, shows chloride concentrations in April during the 5-year drought period (1987–1991) at Antioch, where Table Cl-79 indicated 14% use of assimilative capacity. The figure shows that during 2 of the 5 years, chloride concentrations increased relative to the No Action Alternative (ELT) and decreased in the other 3 years. The absolute differences estimated are fairly small and may be within modeling uncertainty. Figures Cl-22 and Cl-23 in Appendix 8G show a box and whisker plot and exceedance plot for April at Antioch for all dry and critical water years modeled (not just the 1987–1991 drought period). These graphs show that while the median chloride concentration is increased relative to the No Action Alternative (ELT), the maximum value decreased, while the 25th percentile and 75th percentile values remained about the same. Based on this analysis, long-term degradation is not expected at Antioch in April during drought years.

Based on the low level of water quality degradation estimated for the western Delta, and the lack of exceedance of water quality objectives, Alternative 5A is not expected to have substantial adverse effects on municipal and industrial beneficial uses in the western Delta.

CWA Section 303(d) Listed Water Bodies–Relative to No Action Alternative (ELT)

With respect to the state’s CWA Section 303(d) listing for chloride, Alternative 5A would generally result in changes similar to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis, based on changes that would occur in Old River at Tracy Road (Appendix 8G, *Chloride*, Figure Cl-17). Modeling indicated that monthly average chloride concentrations at source water channel locations for the Suisun Marsh would remain similar or decrease relative to the No Action Alternative (ELT) (Appendix 8G, Figures Cl-18, Cl-19, and Cl-20). For these reasons, any changes in chloride in Suisun Marsh are expected to have no adverse effect on marsh beneficial uses.

The effects of Alternative 5A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in chloride in the west Delta. Small increases in chloride concentrations may occur in some areas, but it is not expected that these increases would cause exceedance of Bay-Delta WQCP objectives of cause substantial long-term degradation that would impact municipal and industrial beneficial uses.

SWP/CVP Export Service Areas

Under Alternative 5A in the ELT, long-term average chloride concentrations at the Banks and Jones pumping plants, based on the mass balance analysis of modeling results for the 16-year period, would decrease relative to Existing Conditions. Chloride concentrations would be reduced by 29% at Banks pumping plant (Appendix 8G, *Chloride*, Table Cl-77). At Jones pumping plant, chloride concentrations would be reduced 25% (Appendix 8G, *Chloride*, Table Cl-77). The frequency of exceedances of applicable water quality objectives would be the same relative to Existing Conditions (Appendix 8G, Table Cl-81). The chloride concentration changes relative to the No Action Alternative (ELT) would be similar. Consequently, water exported into the SWP/CVP Export Service Areas would generally be of similar or better quality with regard to chloride relative to Existing Conditions and the No Action Alternative (ELT). Results of the modeling approach which utilized a EC-chloride relationship are consistent these results, and assessment of chloride using these modeling output results in the same conclusions as for the mass balance approach (Appendix 8G, Tables Cl-78 and Cl-82).

Commensurate with the reduced chloride concentrations in water exported to the SWP/CVP Export Service Area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate chloride concentrations at Vernalis.

The effects of Alternative in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative (ELT and LLT), Alternative 5A would not result in substantially increased chloride concentrations in the Delta on a long-term average that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Additional exceedance of the 150 mg/L and 250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use, or any other beneficial use. Based on these findings, this effect is determined to not be adverse.

CEQA Conclusion: Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under Alternative 5A relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, Alternative 5A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 5A would result in substantially increased chloride concentrations in the Delta on a long-term average that would result in adverse effects on the municipal and industrial water supply beneficial use. Additional exceedance of the 150 mg/L and

250 mg/L objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use.

Chloride concentrations would be reduced under Alternative 5A in water exported from the Delta to the SWP/CVP Export Service Areas thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 5A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 5A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas.

Based on these findings, this impact is determined to be less than significant. No mitigation is required. Despite the fact that no mitigation is required, DWR proposed to further reduce any impacts by implementing Mitigation Measure WQ-7e.

Mitigation Measure WQ-7e: Implement Terms of the Contra Costa Water District Settlement Agreement

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 5A would present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. Consequently, as they pertain to chloride, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement relative to the No Action Alternative (ELT and LLT). Therefore, the effects on chloride from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

***CEQA Conclusion*:** Implementation of the Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 5A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP Export Service Areas. Replacement of irrigated agricultural land uses in the Delta with habitat restoration may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance

As described in detail for Alternative 4 (see Section 8.3.3.9), DO levels are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

As described for Alternative 4, amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under Alternative 5A (ELT and LLT) to substantially alter DO levels relative to Existing Conditions or the No Action Alternative (ELT and LLT). Further, the rivers upstream of the Delta are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under Alternative 5A would not be expected to cause DO levels to be outside of the range seen historically. Flow changes that would occur under Alternative 5A would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative (ELT and LLT).

Also as described for Alternative 4, salinity changes would generally have relatively minor effects on Delta DO levels. Further, the relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative (ELT and LLT), such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses. Similarly, increased temperature under Alternative 5A (ELT and LLT), which would be due to climate change, would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Similar to Alternative 4, flows in the San Joaquin River at Stockton under Alternative 5A were evaluated and are shown in Figure 8-65b. The figure shows that while flows do would change somewhat, they are would generally be within the range of flows seen under Existing Conditions and the No Action Alternative. Reports indicate that the aeration facility performs adequately under the range of flows from 250–1,000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will would likely still be located appropriately to keep DO levels above Basin Plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact adverse effect on DO in the Deep Water Ship Channel. It is expected that DO levels in the Deep Water Ship Channel, which is CWA Section 303(d) listed as impaired due to low DO, would remain similar to those under Existing Conditions and the No Action Alternative (ELT and LLT) or improve as TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act Section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No Action Alternative (ELT and LLT), as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

In the SWP/CVP Export Service Areas, the primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. Because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions or the No Action Alternative (ELT and LLT) due to water quality regulations, canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

NEPA Effects: Because DO levels are not expected to change substantially relative to the No Action Alternative (ELT and LLT), the effects on DO from implementing Alternative 5A (ELT and LLT) are determined to not be adverse.

CEQA Conclusion: The effects of Alternative 5A on DO levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for Alternative 4 (see Section 8.3.3.9). Reservoir storage reductions that would occur under Alternative 5A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions would not be expected to result in a substantial adverse change in DO levels in the rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state regulates the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–11 would involve habitat restoration actions. The increased habitat provided by these Environmental Commitments could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying. However, the areal extent of new habitat would be small relative to the existing and No Action Alternative habitat areas, and similar habitat existing in the Delta is not identified as contributing to adverse DO conditions. The remaining Environmental Commitments would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances. Therefore, the effects on DO from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

CEQA Conclusion: It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of Environmental Commitments 3–12, 15, and 16 under Alternative 5A would not be substantially different from existing DO conditions, because these would contribute to a minimal, localized change in oxygen-demanding substances associated with habitat restoration, if at all. Therefore, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are CWA Section 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Based on these findings, this impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 5A on EC levels in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). The extent of new urban growth would be less in the ELT, thus discharges of EC-elevating parameters in runoff and wastewater discharges to water bodies upstream of the Delta would be expected to be less than in the LLT. However, the state is regulating point source discharges of EC-related parameters and implementing a program to further decrease loading of EC-related parameters to tributaries. Based on these considerations, and those described in Section 8.3.3.9, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

For the San Joaquin River, increases in EC levels under Alternative 5A could occur, but would be slightly less than those described for Alternative 4 (see Section 8.3.3.9). This is because the effects of climate change on flows, which could affect dilution of high EC discharges, would be less in the ELT. The implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis are expected to contribute to improved EC levels. Based on these considerations, substantial changes in EC levels in the San

Joaquin River relative to Existing Conditions would not be expected to be of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Initial review of modeling results indicated that Alternative 5A would potentially result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton and the San Joaquin River at Jersey Point relative to Existing Conditions, the San Joaquin River at San Andreas Landing relative to Existing Conditions and the No Action Alternative (ELT), and the San Joaquin River at Prisoners Point relative to the No Action Alternative (ELT) (Appendix 8H, *Electrical Conductivity*, Table EC-26). To understand and interpret these results, considerations must be made regarding uncertainty in the modeling and results from sensitivity analyses. In addition, modeling results indicate there would be small increases in long-term monthly average EC at modeled Suisun Marsh locations relative to Existing Conditions. These locations are addressed in detail below. At all other locations, the level of exceedance and modeled average EC levels under the alternative was approximately equivalent or lower than under Existing Conditions and the No Action Alternative (ELT).

Sacramento River at Emmaton

Modeling results indicated that the Emmaton EC objective would be exceeded more often under Alternative 5A than under Existing Conditions, but less often relative to the No Action Alternative (ELT). The modeling results also indicated that increases in EC could cause substantial water quality degradation in summer months of dry and critical water years. However, these increases in exceedance of the objective and degradation are expected to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Delta Cross Channel operation. Further discussion is provided below.

Modeling results indicated that the percentage of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 10%; there would be a decrease of 2% relative to the No Action Alternative (ELT), from 12% to 10% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The percentage of days out of compliance would increase from 11% under Existing Conditions to 20%; there would be a decrease of 1% relative to the No Action Alternative (ELT), from 21% to 20% (Appendix 8H, Table EC-26). The comparison of the alternative to Existing Conditions reflects changes due both to operation of the alternative as well as effects of sea level rise due to climate change. The comparison of the alternative to the No Action Alternative (ELT) reflects changes in EC due solely to operations of the alternative. Based on the comparison to the No Action Alternative (ELT), the alternative would not contribute to additional exceedance of the EC objective at Emmaton.

The results of the EC modeling indicate there would be months with substantial degradation relative to the No Action Alternative (ELT), particularly during the drought period modeled. Long-term average EC levels at Emmaton would increase in the months of July through September and November by 1–7% for the entire period modeled (1976–1991), and in the months of July, August, and November by 1–25% during the drought period modeled (1987–1991), relative to the No Action Alternative (ELT) (Appendix 8H, *Electrical Conductivity*, Table EC-31). The largest increases in EC would occur in dry and critical water year types. These periods of degradation are expected to be addressed via real-time operations. The level to which modeling output depicts degradation of water quality with respect to EC is primarily a function of the modeling not being able to fully capture how the system would be operated in real-time to minimize or avoid such degradation

Discussions with SWP operators indicated that real-time operations would ensure that the Bay-Delta WQCP EC objectives at Emmaton, applicable from April 1 through August 15, would be met. In latter August and September, the Threemile Slough standard in the North Delta Water Agency Agreement and the Bay-Delta WQCP municipal and industrial objective at Rock Slough are in effect. During this period of the year, the coordinated operations of the SWP/CVP system strives to meet both standards in the most water-efficient method available to the CVP and SWP. Real-time operation would result in less EC degradation than depicted by modeling output because in order to comply with Bay-Delta WQCP objectives and the the North Delta Water Agency Agreement during the summer period, operators could, for example, increase upstream reservoir releases for necessary periods of time, reduce North Delta diversions, and/or close (short-term) the Delta Cross Channel. These options as well as real-time and forecasted tides, winds and barometric pressure are considered when the projects schedule daily operations, which the modeling does not fully capture.

Alternaltive 5A does not change the Bay-Delta WQCP objectives or the the North Delta Water Agency Agreement which are primary drivers of operations and resulting water quality in the Sacramento River at at Emmaton during late August and September. Therefore, the EC degradation at Emmaton that would occur upon implementation of Alternative 5A would be lesser than that shown by the modeling and would not be expected to differ substantially from that which would occur under the No Project Alternative because the compliance targets are not changing due to Alternative 5A during these months and real-time operations would achieve the compliance targets.

The modeling results also show that in the remaining months there would be decreases in EC relative to the No Action Alternative (ELT) of 2–7% for the entire period modeled and 1–10% for the drought period modeled. These decreases would contribute to the long-term average EC levels being similar to No Action Alternative (ELT) for the entire period modeled and decreasing by 1% for the drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-31).

San Joaquin River at San Andreas Landing

Alternative 5A is not expected to have adverse effects on EC in the San Joaquin River at San Andreas Landing, relative to Existing Conditions and the No Action Alternative (ELT). Modeling results estimated that the percentage of days the San Andreas Landing EC objective would be exceeded would increase by <1% relative to Existing Conditions, and the percentage of days out of compliance would increase from 1% under Existing Conditions to 2% (Appendix 8H, *Electrical Conductivity*, Table EC-26). San Andreas Landing average EC would decrease by 7% for the entire period modeled and 3% during the drought period modeled, relative to Existing Conditions (Appendix 8H, *Electrical Conductivity*, Table EC-31). Results relative to the No Action Alternative (ELT) were similar (Appendix 8H, *Electrical Conductivity*, Table EC-31). Sensitivity analyses performed for Alternative 4 Scenario H3 at the LLT indicate that many of these exceedances are likely modeling artifacts, and the small number of remaining exceedances would be small in magnitude, lasting only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1, *Models Used and Their Linkages*, for a description of real time operations of the SWP and CVP). These sensitivity analyses were only run at the LLT, but it is expected that the findings can generally be extended to the ELT, because the factors affecting salinity findings in the sensitivity analysis (e.g., modeling assumptions, physical hydrodynamic mechanisms) are similar between the ELT and LLT (see Appendix 8H Attachment 1,).

San Joaquin River at Prisoners Point

Modeling results indicated that the EC objective that applies to the San Joaquin River between Jersey Point and Prisoners Point would be exceeded at Prisoners Point more often under Alternative 5A than under the No Action Alternative (ELT), but less often relative to Existing Conditions. The exceedances relative to the No Action Alternative (ELT) are expected to be able to be addressed via real-time operations, including real time management of the north Delta and south Delta intakes, as well as Head of Old River Barrier management. Further discussion is provided below.

Modeling results estimated that the percentage of days the Prisoners Point EC objective would be exceeded would increase from 2% under the No Action Alternative (ELT) to 4% and the percentage of days out of compliance with the EC objective would increase from 2% under the No Action Alternative (ELT) to 6% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The magnitude and duration of these differences is expected to be within the modeling uncertainty, indicating no measurable change in EC would be expected in the environment.

San Joaquin River at Jersey Point

Modeling results indicated that the EC objective that applies between the San Joaquin River at Jersey Point and Prisoners Point also would be exceeded at Jersey Point more often under Alternative 5A than under Existing Conditions, and less often relative to the No Action Alternative (ELT). At Jersey Point, modeling results estimated that the percentage of days the EC objective would be exceeded would change from 0% under Existing Conditions, or 3% under the No Action Alternative (ELT), to 2%, and the percentage of days out of compliance with the EC objective would change from 0% under Existing Conditions, or 3% under the No Action Alternative (ELT), to 2% (Appendix 8H, *Electrical Conductivity*, Table EC-26). The incremental change in the frequency of objective exceedance relative to the No Action Alternative (ELT), which reflects only the effects due to the alternative, and not effects of climate change, sea level rise and water demands, would be a reduction of 1%. Therefore, the alternative would not contribute to additional exceedances of the EC objective at Jersey Point.

Suisun Marsh

For Suisun Marsh October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Modeling results indicate that average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March and April relative to Existing Conditions, by 0.1 mS/cm (Appendix 8H, *Electrical Conductivity*, Table EC-32). In Montezuma Slough at National Steel, average EC levels would increase in March through May by 0.1–0.2 mS/cm (Appendix 8H, *Electrical Conductivity*, Table EC-33).). There would be similarly small increases in long-term average EC in the months of March through May in Montezuma Slough near Beldon's Landing, Chadbourne Slough near Sunrise Duck Club, and Suisun Slough near Volanti Slough, ranging 0.1–0.4 mS/cm depending on month and location (Appendix 8H, *Electrical Conductivity*, Tables EC-34 through EC-36). Relative to the No Action Alternative (ELT), the modeled long-term average EC under the alternative would be similar or lower from October through May for these locations (Appendix 8H, *Electrical Conductivity*, Tables EC-32 through EC-36).

The Suisun Marsh EC objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). Long-term average EC increases relative to Existing Conditions may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the Marsh. Given the Bay-Delta WQCP narrative objective regarding “equivalent or better protection” in lieu of meeting specific numeric objectives, the small increase in EC under Alternative 5A, relative to Existing Conditions, would not be expected to adversely affect beneficial uses of Suisun Marsh. While Suisun Marsh is CWA Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) relative to the daily fluctuations in EC levels as to not be measurable and beneficial uses would not be adversely affected.

Further, the EC changes in Suisun Marsh relative to Existing Conditions reflect the influence of both operations of the alternative and sea level rise due to climate change, whereas the changes relative to the No Action Alternative (ELT) are due solely to operations of the alternative. As described above, there would be no increase in the long-term average EC at modeled Suisun Marsh locations, and for some locations long-term average EC would decrease. Therefore, it is expected that this alternative would not contribute to exceedances of EC objectives or additional impairment of beneficial uses, as affected by EC or other salinity-related parameters.

The effects of Alternative 5A in the LLT in the Delta region, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be similar to effects in the ELT. With greater climate change and sea level rise, additional outflow may be required at certain times to prevent increases in EC in the west Delta, but this requirement would not be due to the alternative.

SWP/CVP Export Service Areas

Under Alternative 5A, at the Banks pumping plant, the frequency of exceedance of the EC objective would be 1% for the entire period modeled and 2% for the drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-27). Relative to Existing Conditions, average EC levels under Alternative 5A would decrease 19% for the entire period modeled and 17% during the drought period modeled (Appendix 8H, *Electrical Conductivity*, Table EC-31). Relative to the No Action Alternative (ELT), average EC levels would similarly decrease, by 15% for the entire period modeled and drought period modeled ((Appendix 8H, *Electrical Conductivity*, Table EC-31).

At the Jones pumping plant, the frequency of exceedance of the EC objective would be 1% for the entire period modeled and 0% for the drought period modeled. Relative to Existing Conditions, average EC levels under Alternative 5A would decrease 16% for the entire period modeled and 17% during the drought period modeled. Relative to the No Action Alternative (ELT), average EC levels would similarly decrease, by 13% for the entire period modeled and 15% for the drought period modeled ((Appendix 8H, *Electrical Conductivity*, Table EC-31).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 5A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas. Rather, Alternative 5A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC Alternative 5A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative (ELT) and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

The effects of Alternative 5A in the LLT in the SWP/CVP Export Service Areas, relative to Existing Conditions and the No Action Alternative (LLT), would be expected to be very similar to effects in the ELT. The difference in these timeframes that could contribute to EC differences between the ELT and LLT is climate change and sea level rise, and thus would not be due to the alternative.

NEPA Effects: In summary, based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the western, interior, or southern Delta. However, modeling results indicate that there could be increased long-term and drought period average EC levels during the summer months that would occur in the western Delta (i.e., in the Sacramento River at Emmaton) under Alternative 5A relative to the No Action Alternative (ELT), that could contribute to adverse effects on the agricultural beneficial uses. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to increase under Alternative 5A, relative to the No Action Alternative (ELT), and thus it is not expected to contribute to additional beneficial use impairment. The increases in EC in the Sacramento River at Emmaton, particularly during summer months of dry and critical water years, and the additional exceedances of water quality objectives in the San Joaquin River at Prisoners Point constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects.

CEQA Conclusion: River flow rate and reservoir storage reductions that would occur under Alternative 5A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 5A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas, and exceedance of the Bay-Delta WQCP EC objective would be infrequent. Average EC levels for the entire period modeled would decrease at both the Banks and Jones pumping plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Further, relative to Existing Conditions, Alternative 5A would not result in substantial increases in long-term average EC in Suisun Marsh. Thus, EC levels in Suisun Marsh are not expected to further degrade existing EC levels and thus would not contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, any changes in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA Section 303(d) listed as impaired due to elevated EC, but EC levels are not expected to change substantially under Alternative 5A, relative to Existing Conditions, and thus it is not expected that they would contribute to additional beneficial use impairment.

In the Plan Area, Alternative 5A is not expected to result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded, except for at the San Joaquin River at Jersey Point (fish and wildlife objective: 2% increase). The increased frequency of exceedance is due to the combined effects of operations of the alternative along with climate change, sea level rise and increased water demands. A comparison to the No Action Alternative (ELT) results reveals that the alternative would not contribute to additional exceedance at Jersey Point and, thus, there would likely be no adverse effects to aquatic life at Jersey Point. However, there would be a discernible increased frequency of exceedance of the fish and wildlife objective at Prisoners Point that could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. However, by adaptively managing the Head of Old River Barrier and the fraction of south Delta versus north Delta diversions, EC levels at Prisoners Point would likely be decreased to a level that would not adversely affect aquatic life beneficial uses.

Average EC levels at Emmaton were modeled to increase by 9% during the drought period modeled. The largest monthly average increases in EC were modeled to occur during the summer months of the drought period, and more generally in dry and critical water year types. The increases in drought period average EC levels modeled could cause substantial water quality degradation that would potentially contribute to adverse effects on the agricultural beneficial uses in the western Delta. The comparison to Existing Conditions reflects changes in EC due to both Alternative 5A operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton would be due in part to the effects of climate change/sea level rise, and in part due to Alternative 5A operations. This is evidenced by the significant effects expected in the No Action Alternative (ELT) at Emmaton relative to Existing Conditions, as well as the fact that a lesser level of adverse effects is expected at Emmaton under Alternative 5A relative to the No Action Alternative (ELT). During summer of dry and critical water years, additional flow in the Sacramento River at Emmaton would reduce or eliminate increases in EC. It is expected that for July–August of dry and critical water years, real-time operations that would include more precise management of upstream reservoir realeases on a daily basis and less pumping from the north Delta intakes and greater reliance on south Delta intakes than that modeled would allow for enough flow in the Sacramento River at Emmaton to reduce water quality degradation to levels closer to the No Action Alternative that would not be expected to adversely affect beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is CWA Section 303(d) listed for elevated EC and the increased EC degradation that was modeled in the western Delta could make beneficial use impairment measurably worse.

Based on these findings, this impact in the Plan Area is considered to be significant. Implementation of Mitigation Measure WQ-11 would be expected to reduce these effects to a less-than-significant level.

Mitigation Measure WQ-11: Avoid or Minimize Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 4A.

Mitigation Measure WQ-11e: Adaptively Manage Diversions at the North and South Delta Intakes to Reduce or Eliminate Water Quality Degradation in Western Delta

Please see Mitigation Measure WQ-11e under Impact WQ-11 in the discussion of Alternative 4A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these Environmental Commitments would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration activities would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

Environmental Commitment 4 would result in some tidal habitat restoration, however, the areal extent would be small relative to the existing and No Action Alternative tidal area and, thus not expected to appreciably affect the magnitude of daily tidal water exchange at the restoration areas or alter other hydrodynamic conditions in adjacent Delta channels that would result in measurable EC changes.

In summary, implementation of the Environmental Commitments would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment. Therefore, the effects on EC from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 under Alternative 4A would not present new or substantially changed sources of EC to the affected environment. Some Environmental Commitments may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of the Alternative 5A on mercury levels in surface waters upstream of the Delta relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors that affect mercury concentrations in surface waters upstream of the Delta are similar under Alternatives 4 and 5A. The changes in flow in the Sacramento River under Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT) would not be of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore, mercury loading should not be substantially different due to changes in flow. In addition, even though they may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but would not change substantially because the anticipated changes in flow are not expected to substantially change mercury loading relative to Existing Conditions or the No Action Alternative (ELT).

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury. TMDLs and the State Water Board's Statewide Mercury Control Program. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

Delta

The effects of Alternative 5A on waterborne concentrations of mercury (Appendix 8I, *Mercury*, Table I-17) and methylmercury (Appendix 8I, *Mercury*, Table I-18), and fish tissue mercury concentrations for largemouth bass fillet (Appendix 8I, *Mercury*, Tables I-22a and I-22b) were evaluated for nine Delta locations.

Increases in long-term average mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) would be very small, 0.2 ng/L or less. Also, use of assimilative capacity for mercury relative to the 25 ng/L ecological threshold under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT), would be very low, about 1% or less, as a long-term average, for all Delta locations (Appendix 8I, *Mercury*, Table I-25). These concentration changes and small changes in assimilative capacity for mercury are not expected to result in adverse (or positive) effects to beneficial uses.

Changes in methylmercury concentrations in water also are expected to be very small. The greatest annual average methylmercury concentration under Alternative 5A would be 0.168 ng/L for the San Joaquin River at Buckley Cove, for the drought period modeled, which would be slightly higher than Existing Conditions (0.161 ng/L) and the same as the No Action Alternative (ELT) (0.168 ng/L) (Appendix 8I, *Mercury*, Table I-18). All methylmercury concentrations in water were estimated to exceed the TMDL guidance objective of 0.06 ng/L under Existing Conditions and, therefore, no assimilative capacity exists.

Fish tissue estimates for largemouth bass fillet show small or no increases in mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) based on long-term annual average concentrations for mercury at the Delta locations. Concentrations expected for Alternative 5A, with Equation 1, show increases of 5% or less, relative to Existing Conditions and the No Action Alternative (ELT), in all years (Appendix 8I, *Mercury*, Table I-22a). With Equation 2, increases relative to Existing Conditions and the No Action Alternative (ELT) are estimated to be 7% or less (Appendix 8I, *Mercury*, Table I-22b).

Because the increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I, *Mercury*, for a complete discussion of the uncertainty associated with the fish tissue estimates. Briefly, the bioaccumulation models contain multiple sources of uncertainty associated with their development. These are related to: analytical variability; temporal and/or seasonal variability in Delta source water concentrations of merthylmercury; interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and limited sample size (both in number of fish and time span over which the measurements were made), among others. Although there is considerable uncertainty in the models used, the results serve as a reasonable approximations of a very complex process. Considering the uncertainty, small (i.e., < 20–25%) increases or decreases in modeled fish tissue mercury concentrations at a low number of Delta locations (i.e., 2–3) should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual adverse effects. Larger increases, or increases evident throughout the Delta, can be interpreted as more reliable indicators of potential adverse effects.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 5A, at the Jones and Banks pumping plants were lower than Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, *Mercury*, Tables I-17 and I-18). Therefore, mercury shows an increased assimilative capacity at these locations (Appendix 8I, *Mercury*, Table I-24).

The largest improvements in largemouth bass tissue mercury concentrations and Exceedance Quotients ([EQs]); modeled tissue divided by TMDL guidance concentration) for Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT) at any location within the Delta are expected for the Banks and Jones pumping plants export pump locations. Concentrations expected for Alternative 5A at the export pump locations with Equation 1 in all years show decreases relative to Existing Conditions (4% to 5%) and relative to the No Action Alternative (ELT) (6%) (Appendix 8I, *Mercury*, Table I-22a). Concentrations expected for Equation 2 in all years show decreases relative to Existing Conditions (6% to 7%) and relative to the No Action Alternative (ELT) (8%) (Appendix 8I, *Mercury*, Table I-22a).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

NEPA Effects: Based on the above discussion, Alternative 5A would not cause concentrations of mercury and methylmercury in water and fish tissue in the affected environment to be substantially different from the No Action Alternative (ELT and LLT) and, thus, would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to the No Action Alternative (ELT and LLT), Alternative 5A would not be expected to increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, the effects of Alternative 5A on mercury in the affected environment are considered to be not adverse.

CEQA Conclusion: Under Alternative 5A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta would not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record under Alternative 5A would be very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show small differences would occur among sites for Alternative 5A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP/CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 5A, as compared to Existing Conditions.

As such, Alternative 5A is expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 5A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: The potential types of effects on mercury resulting from implementation of the Environmental Commitments under Alternative 5A would be generally similar to those described under Alternative 4 (see Section 8.3.3.9). However, the magnitude of effects on mercury and methylmercury at locations upstream of the Delta, in the Delta, and the SWP/CVP Export Service Areas related to habitat restoration would be considerably lower than described for Alternative 4. This is because the amount of habitat restoration to be implemented under Alternative 5A would be very low compared to the total proposed restoration area that would be implemented under Alternative 4. The small amount of habitat restoration to be implemented under Alternative 5A may occur on lands in the Delta formerly used for irrigated agriculture. Habitat restoration proposed under Alternative 5A has the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the vicinity of the restored habitat areas. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, the uncertainties related to site-specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta in the vicinity of the restored areas. Therefore, the effect of Environmental Commitments 3, 4, 6–12, 15, and 16 on mercury and methylmercury is considered to be adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 relative to Existing Conditions. However, in the Delta, due to the small amount of tidal restoration areas proposed, relative to Existing Conditions, uptake of mercury from water and/or methylation of inorganic mercury may increase in localized areas as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Although not quantifiable, on a local level, increases in methylmercury concentrations may be measurable. Methylmercury is CWA Section 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites would be guided by Environmental Commitment 12, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore, this impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

As described for Alternative 4 (in Section 8.3.3.9), nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the reservoirs and rivers relative to the magnitude of the point and non-point source discharges, and there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions or the No Action Alternative (ELT), are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento River watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49; Figure 2 in Appendix 8J, *Nitrate*). Under Alternative 5A, long-term average flows at Vernalis would decrease an estimated 1% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (ELT). Given the relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative (ELT and LLT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any negligible changes in nitrate concentrations that may occur under Alternative 5A in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to nitrate.

Delta

Mass balance calculations indicate that under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Appendix 8J, *Nitrate*, Table 34). Although changes at specific Delta locations and for specific months may be substantial on a relative basis (Appendix 8J, *Nitrate*, Table 41), the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds (see *Nitrate* under Section 8.3.1.7, *Constituent-Specific Considerations Used in the Assessment*). Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 Delta assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentrations would be somewhat reduced under Alternative 5A relative to Existing Conditions and slightly increased relative to the No Action Alternative (ELT). No additional exceedances of the MCL are anticipated at any location under Alternative 5A (Appendix 8J, *Nitrate*, Table 34).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under Alternative 5A would be low or negligible (i.e., <3%) in comparison to both Existing Conditions and the No Action Alternative (ELT), for all locations and months, for all modeled years (1976–1991), and for the drought period (1987–1991) (Appendix 8J, *Nitrate*, Table 42).

As described for Alternative 4, actual nitrate concentrations would likely be higher than the modeling results indicate in certain locations under Alternative 5A. This is the mass balance modeling does not account for contributions from the SRWTP, which would be implementing nitrification/partial denitrification, or Delta wastewater treatment plant dischargers that practice nitrification, but not denitrification. However, for the reasons described for Alternative 4, any increases in nitrate concentrations that may occur at certain locations within the Delta under Alternative 5A would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regard to nitrate.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Assessment of effects of Alternative 5A on nitrate in the SWP/CVP. Export Service Areas is based on effects on nitrate at the Banks and Jones pumping plants. Results of the mass balance calculations indicate that relative to Existing Conditions and the No Action Alternative (ELT), nitrate concentrations at Banks and Jones pumping plants under Alternative 5A are anticipated to decrease on a long-term average annual basis by 17% at the Banks pumping plant and 14% at the Jones pumping plant (Appendix 8J, *Nitrate*, Table 41). During the late summer, particularly in the drought period assessed, concentrations are expected to increase, but the absolute value of these changes (i.e., in mg/L-N) would be small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Areas, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.2 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP/CVP Export Service Areas. No additional exceedances of the MCL are anticipated under Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8J, *Nitrate*, Table 34). On a monthly average basis and on a long-term annual average basis, for all modeled years and for the drought period only, use of assimilative capacity available under Existing Conditions and the No Action Alternative (ELT), relative to the 10 mg/L-N MCL, would be negligible (<2%) for both Banks and Jones pumping plants (Appendix 8J, *Nitrate*, Table 42).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on nitrate in the LLT are expected to be similar to those described above.

Any increases in nitrate concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regard to nitrate.

NEPA Effects: Modified reservoir operations and subsequent changes in river flows under Alternative 5a, relative to the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. In the Delta, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any Delta location, and use of assimilative capacity available under the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, would be low. Long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to differ negligibly relative to the No Action Alternative (ELT and LLT) and no additional exceedances of the 10 mg/L-N MCL are anticipated. Therefore, the effects on nitrate from implementing water conveyance facilities are considered to be not adverse.

CEQA Conclusion: Nitrate concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers).Although higher in the San Joaquin River watershed, nitrate concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mass balance calculations indicate that under Alternative 5A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the 10 mg/L-N MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, would be low or negligible (i.e., <3%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP/CVP Export Service Areas is based on effects on nitrate concentrations at the Banks and Jones pumping plants. Results of the mass balance calculations indicate that under Alternative 5A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the 10 mg/L-N MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL would be negligible (i.e., <2%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under Alternative 5A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Some habitat restoration activities included in Environmental Commitments 3, 4, and 6–11 would occur on lands within the Delta formerly used for agriculture. As discussed for Impact WQ-2, increased biota that may result in those areas may increase ammonia, which in turn may be converted to nitrate by established microbial communities. However, the areal extent of the new habitat implemented for the Environmental Commitments would be less than the existing and No Action Alternative habitat areas, and similar habitat exists currently in the Delta and is not identified as contributing to adverse nitrate conditions. Thus, these land use changes would not be expected to substantially increase nitrate concentrations in the Delta. Implementation of Environmental Commitments 12, 15, and 16 do not include actions that would affect nitrate sources or loading. Based on these findings, the effects on nitrate from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

***CEQA Conclusion*:** Land use changes that would occur from the Environmental Commitments are not expected to substantially increase nitrate concentrations, because the amount of area to be converted would be small relative to existing habitat, and existing habitats are not known for contributing to adverse nitrate conditions. Thus, it is expected that implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 5A on DOC concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 because factors affecting DOC concentrations in these water bodies would be similar. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under Alternative 5A would not be expected to cause substantial long-term changes in DOC concentrations in the water bodies upstream of the Delta. Any changes in DOC levels in water bodies upstream of the Delta under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies.

Delta

Under Alternative 5A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be less extensive, and the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be lower than described for Alternative 4. The effects of Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT) are discussed together because the direction and magnitude of predicted change are similar. Relative to the Existing Conditions and No Action Alternative (ELT), Alternative 5A would result in small increases in long-term average DOC concentrations for both the modeled 16-year period (1976–1991) and drought period (1987–1991) at several interior Delta locations (increases up to 0.1 mg/L at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1) (Appendix 8K, *Organic Carbon*, Table DOC-13). The increases in average DOC concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at the Contra Costa Pumping Plant #1 associated with the 3 mg/L threshold (i.e., increase from 52% under Existing Conditions to 61% under Alternative 5A for the modeled 16-year period). The change in frequency of threshold concentration exceedances at other assessment locations would be similar or lower.

While Alternative 5A would lead to slightly higher long-term average DOC concentrations at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. As discussed for Alternative 4, substantial changes in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 5A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Relative to Existing Conditions and the No Action Alternative (ELT and LLT), Alternative 5A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below).

SWP/CVP Export Service Areas

Under the Alternative 5A, long-term average DOC concentrations would decrease at Barker Slough by 0.1 mg/L, and at both the Banks and Jones pumping plants by 0.2 mg/L, relative to Existing Conditions. Reductions would be similar compared to No Action Alternative (ELT) (Appendix 8K, *Organic Carbon*, Table DOC-13). Decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedances of the 3 mg/L threshold during the modeled drought period would increase at the Banks and Jones pumping plants. Relative to Existing Conditions, exceedance of the 3 mg/L threshold would increase from 57% 70% at Banks pumping plant and from 72% to 85% at Jones pumping plant. There would be little to no increase in exceedance of the 3 mg/L threshold relative to the No Action Alternative (ELT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on DOC in the LLT are expected to be similar to those described above.

Maintenance of SWP and CVP facilities under Alternative 5A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area.

NEPA Effects: In summary, the operations and maintenance activities under Alternative 5A, relative to the No Action Alternative (ELT and LLT), would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. The long-term average DOC concentrations at the Barker Slough and Banks and Jones pumping plants are predicted to decrease by 0.2 mg/L, while long-term average DOC concentrations for some Delta interior locations are predicted to increase by as much as 0.1 mg/L. However, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. Based on these findings, the effect of operations and maintenance activities on DOC under Alternative 5A is determined to be not adverse.

CEQA Conclusion: For the same reasons described for Alternative 4, the operations and maintenance activities under Alternative 5A, relative to the Existing Conditions, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. Any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DOC levels upstream of the Delta. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the Alternative 5A would result in relatively small increases (i.e., ≤0.1 mg/L) in long-term average DOC concentrations at some interior Delta locations. The predicted increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. Because this alternative would lead to only slightly higher long-term average DOC concentrations at the interior Delta locations and some municipal water intakes, the predicted changes would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

Relative to Existing Conditions, Alternative 5A would result in reduced long-term average DOC concentrations at the Banks and Jones pumping plants and Barker Slough. However, Alternative 5A would result in slightly greater frequency of exceedance of the 3 mg/L DOC concentration threshold during the modeled drought period. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Alternative 5A would not result in any substantial change in long-term average DOC concentration. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Relative to existing habitat and that to be developed under the No Action Alternative (ELT and LLT), the area of new habitat restoration implemented for the Environmental Commitments would be very small. Implementation of non-habitat restoration Environmental Commitments would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, any increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Based on these findings, the effect of the Environmental Commitments on DOC is determined to be not adverse.

CEQA Conclusion: Implementation of habitat restoration Environmental Commitments is not expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas, relative to the Existing Conditions, because the land area proposed for restoration would be relatively small compared to existing land area and sources of DOC. Implementation of other Environmental Commitments also would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas, because they would present no major sources of DOC to the affected environment. Consequently, increases in average DOC levels in the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regard to DOC. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not CWA Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 5A on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those effects described for Alternative 4 (see Section 8.3.3.9). As described for Alternative 4, pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers. Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows and that pathogen concentrations in the rivers have a minimal relationship to river flow rate, river flow rate and reservoir storage reductions that would occur under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta.

The effects of Alternative 5A relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed. However, as described for Alternative 4, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens, because it is expected that pathogen sources in close proximity to Delta sites would have a greater influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

As such, Alternative 5A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

NEPA Effects: Because pathogen levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on pathogens from implementing Alternative 5A are determined to not be adverse.

CEQA Conclusion: The effects of Alternative 5A on pathogen levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas, relative to Existing Conditions, would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because the factors that would affect pathogen levels in the surface waters of these areas would be similar. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Environmental Commitments 3, 4, and 6–11 would involve habitat restoration actions. This could result in localized increases in wildlife-related coliforms relative to the No Action Alternative (ELT and LLT). The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. The remaining Environmental Commitments would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources. Based on these findings, the effects on pathogens from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of Environmental Commitments 3, 4, and 6–11 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the CWA Section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, the Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is CWA Section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 5A operations and maintenance on pesticide levels in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT), would be similar to those expected to occur under Alternative 4 (see Section 8.3.3.9). This is because under Alternative 5A, the primary factor that would influence pesticide concentrations in surface waters upstream of the Delta—the effect of timing and magnitude of reservoir releases on dilution capacity—is expected to change by a similar degree. Changes in average winter and summer flow rates, relative to Existing Conditions and the No Action Alternative (ELT), are expected to be similar to or less than changes in flow rates expected under Alternative 4 in the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis (Appendix 8L, *Pesticides,* Tables 1–4). Similarly, the primary factor that would influence pesticide concentrations in surface waters of the Delta and in the SWP/CVP Export Service Areas (i.e., changes in San Joaquin River, Sacramento River and Delta Agriculture source water fractions at various Delta locations, including Banks and Jones pumping plants) is expected to change by a similar degree. The percentage change in monthly average source water fractions would be similar to changes expected under Alternative 4 (Appendix 8D, *Source Water Fingerprinting Results*).

It was concluded for Alternative 4, and thus for Alternative 5A based on similar flow changes, that the potential average summer flow reductions would not be of sufficient magnitude to substantially increase in-river pesticide concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses upstream of the Delta. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered. Similarly, the modeled changes in the source water fractions of Sacramento River, San Joaquin River, and Delta agriculture water under Alternative 5A would not be of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of organophosphate insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

The flow changes in the LLT would be expected in the ranges of that described above for Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT), and that described for Alternative 4 relative to the No Action Alternative (LLT) in Section 8.3.3.9. Thus, similar to above and Alternative 4, the flow changes that would occur in the LLT under Alternative 5A, relative to Existing Conditions and the No Action Alternative (LLT), would not be expected to result in changes in dilution of pesticides of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses upstream of the Delta, in the Delta, or the SWP/CVP Export Service Areas.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers under Alternative 5A relative to the No Action Alternative (ELT and LLT) would be of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, changes in source water fractions to the Delta would be of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP Export Service Areas. Therefore, the effects on pesticides from the water conveyance facilities are determined not to be adverse.

CEQA Conclusion: Based on the discussion above, the effects of Alternative 5A on pesticide levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to or slightly less than those described for the Alternative 4. Alternative 5A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous CWA Section 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under Alternative 5A would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly. Therefore, relative to the No Action Alternative (ELT and LLT), the effects on pesticides from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of pesticides, and the potential short-term loading from former agricultural lands would be expected to degrade and dissipate rapidly, such that pesticide levels would differ little from Existing Conditions. Therefore, implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increase in pesticide concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas. As such, these Environmental Commitments are not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pesticide concentrations are not expected to increase substantially, no long-term water quality degradation for pesticides is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term pesticide concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. Environmental Commitments 3, 4, 6–12, 15, 16 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the Environmental Commitments propose the use of any pesticide currently named in a CWA Section 303(d) listing of the affected environment. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

The effects of Alternative 5A on phosphorus concentrations in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas would be similar to those described for Alternative 4 (see Section 8.3.3.9). This is because factors which affect phosphorus concentrations in surface waters of these areas are the same under Alternative 4 and Alternative 5A. As described for Alternative 4, phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under Alternative 5A, relative to Existing Conditions or the No Action Alternative (ELT), upstream of the Delta. Phosphorus concentrations may increase during January through March at locations in the Delta where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. However, based on the DSM2 fingerprinting results (Figures 353–374 in Appendix 8D, *Source Water Fingerprinting Results*), together with source water concentrations (in Figure 8-56), the magnitude of increases during these months is expected to be negligible to low (i.e., <0.02 mg/L) at all Delta locations relative to Existing Conditions and the No Action Alternative (ELT and LLT). Thus, phosphorus concentrations in the Delta and waters exported from Banks and Jones pumping plants to the SWP/CVP Export Service Areas are expected to be similar to Existing Conditions and the No Action Alternative (ELT and LLT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on phosphorus in the LLT are expected to be similar to those described above.

NEPA Effects: In summary, operation of the water conveyance facilities would have little to no effect on phosphorus concentrations in water bodies upstream of the Delta, in the Plan Area, and the waters exported to the SWP/CVP Export Service Areas, relative to the No Action Alternative (ELT and LLT). Thus, effects of the water conveyance facilities on phosphorus are considered to be not adverse.

CEQA Conclusion**:** The effects of Alternative 5A on phosphorus levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions would be similar to those described for the Alternative 4. There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 5A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, relative to the No Action Alternative (ELT and LLT), the effects on phosphorus from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 do not involve actions that would contribute long-term additional loading of phosphorus. Therefore, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the SWP/CVP Export Service Areas due to implementation of these Environmental Commitments relative to Existing Conditions. Because phosphorus concentrations are not expected to increase substantially due to these Environmental Commitments, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not CWA Section 303(d) listed within the affected environment and, thus, the Environmental Commitments would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, any increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

The effects of Alternative 5A on selenium concentrations in reservoirs and rivers upstream of the Delta would be similar to those effects described for Alternative 4 (see Section 8.3.3.9), because factors affecting selenium concentrations in these water bodies would be similar. Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions or the No Action Alternative (ELT and LLT), are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta. Similarly, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under Alternative 5A, given the relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Alternative 5A would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative (ELT) at all modeled Delta assessment locations (Appendix 8M, *Selenium,* Table M-33). Long-term average concentrations at some interior and western Delta locations would increase by 0.01 µg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (2% or less) in available assimilative capacity for selenium, relative to USEPA's draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-46). The long-term average selenium concentrations in water under Alternative 5A (range 0.09–0.39 µg/L) would be similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (ELT) (range 0.09–0.39 µg/L), and would be below the draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 5A would result in small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Appendix 8M, *Selenium,* Tables M-36 and M-40). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0, indicating low probability of adverse effects. Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by 7% relative to Existing Conditions (from about 4.7 to about 5.0 mg/kg dry weight) and by 4% relative to the No Action Alternative (ELT) in all years (from about 4.8 to about 5.0 mg/kg dry weight). For sturgeon in the Sacramento River at Mallard Island concentrations are predicted to increase by about 5% relative to Existing Conditions in all years (from about 4.4 to 4.6 mg/kg dry weight) and by 3% relative to the No Action Alternative in all years (from about 4.5 to 4.6 mg/kg dry weight) (Appendix 8M, *Selenium,* Tables M-41 and M-42). Selenium concentrations in sturgeon during drought years are expected to increase by about 3–5% relative to Existing Conditions (from about 6.8 to 7.2 mg/kg dry weight) and 1–2% relative to the No Action Alternative at those locations (from about 7.0 to 7.2 mg/kg dry weight) (Appendix 8M, *Selenium,* Tables M-41 and M-42). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative (ELT)); for all years the Exceedance Quotient would be 1.0 or less (Appendix 8M, Table M-43). The High Toxicity Threshold Quotient would be less than 1.0 at both locations for all years and drought years (Appendix 8M, Table M-43).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the Appendix 8M, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium. Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Residence time of water in the Delta is expected to increase relative to Existing Conditions primarily as a result of habitat restoration (8,000 acres of tidal habitat restoration and enhancements in the Yolo Bypass) that is assumed to occur under the No Action Alternative (ELT) separate from Alternative 5A. Although estimates of the residence time increases are not available for Alternative 5A, estimates for Alternative 5 at the Late Long Term (presented in Table 8-60a in Section 8.3.1.7 in the *Microcystis* subsection) which contained 65,000 acres of tidal restoration are available, and is expected that residence time increases under Alternative 5A would be substantially less than identified for Alternative 5 in the table.

If increases in fish tissue or bird egg selenium were to occur as a result of increased residence time, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. Thus, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time would be a concern is the western Delta and Suisun Bay for sturgeon. Based on the expected minor increases in residence time in the western Delta, any increases are not expected to be of sufficient magnitude to substantially affect selenium bioaccumulation.

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 5A would result in essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark during the drought period, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 5A would not be expected to substantially increase the frequency with which the applicable water quality criterion or toxicity and level of concern benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or to substantially degrade the quality of water in the Delta, with regard to selenium. These changes would be similar to those described for Alternative 4.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

SWP/CVP Export Service Areas

Alternative 5A would result in small (0.03 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative (ELT), for the entire period modeled (Appendix 8M, *Selenium,* Table M-33). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants, relative to the USEPA's draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-46). The long-term average selenium concentrations in water for Alternative 5A (range 0.18–0.25 μg/L) would be well below the draft water quality criterion of 1.3 μg/L (Appendix 8M, Table M-33).

Relative to Existing Conditions and the No Action Alternative (ELT), Alternative 5A would result in small changes (about 1% or less) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, *Selenium,* Table M-40). Concentrations in biota would not exceed any selenium toxicity or level of concern benchmarks for Alternative 5A (Appendix 8M, Table M-40).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on selenium in the LLT are expected to be similar to those described above.

NEPA Effects: Relative to the No Action Alternative (ELT and LLT), Alternative 5A would result in essentially negligible changes in selenium concentrations in water upstream of the Delta. Similarly, there would be negligible changes in selenium water and most biota concentrations in the Delta, with no exceedances of benchmarks for biological effects. For sturgeon in the Delta, there would be only a small increase of threshold exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark. At the Banks and Jones pumping plants, Alternative 5A would cause no increases in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations. Therefore, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 5A are considered to be not adverse.

***CEQA Conclusion*:** There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Regional Water Quality Control Board 2010d; State Water Resources Control Board 2010b, 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate Alternative 5A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance

Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions to 1.0 for Alternative 5A. Concentrations of selenium in sturgeon would exceed only the lower benchmark during the drought period, indicating a low potential for effects. Overall, Alternative 5A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 5A would cause no increases in the frequency with which applicable benchmarks would be exceeded, and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 5A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under Alternative 5A would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to the No Action Alternative (ELT and LLT). Therefore, the effects on selenium from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusion: Environmental Commitments 3, 4, 6–12, 15, and 16 would not increase selenium loading, and the amount of restoration that would occur would be minimal relative to the area of the Delta and implemented such that any localized changes in residence time are unlikely to measurably change selenium concentrations in water or biota relative to Existing Conditions. Therefore, it is expected that with implementation of these Environmental Commitments there would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the SWP/CVP Export Service Areas, relative to Existing Conditions. As such, these Environmental Commitments would not contribute to additional exceedances of applicable water quality objectives/criteria. Given the factors discussed in the assessment above and for Alternative 4 (see Section 8.3.3.9), any increases in bioaccumulation rates from waterborne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, these Environmental Commitments would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a CWA Section 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see BDCP Appendix 3.C, *Avoidance and Minimization Measures*, for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

The effects of operation of the water conveyance facilities under Alternative 5A on trace metal concentrations in surface waters upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT) would be similar to those effects described for Alternative 4 (see Section 8.3.3.9).

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta.

In the Delta, for metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, and very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based (see Tables 8-51 and 8-52 in Section 8.3.1.7, *Construction-Specific Considerations Used in the Assessment*). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur. For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar (see Tables 8–10 in Appendix 8N,*Trace Metals*) and average concentrations are below human health criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur.

Because Alternative 5A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP Export Service Areas, relative to Existing Conditions or the No Action Alternative (ELT and LLT).

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on trace metals in the LLT are expected to be similar to those described above.

As such, Alternative 5A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: Alternative 5A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment or substantially degrade the quality of these water bodies, with regard to trace metals, relative to the No Action Alternative (ELT and LLT). Therefore, the effects on trace metals from implementing Alternative 5A are determined to not be adverse.

CEQA Conclusion: While Alternative 5A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, this would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under Alternative 5A.

Because Alternative 5A is not expected to result in substantial changes in trace metal concentrations in Delta waters, which includes Banks and Jones pumping plants, effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

NEPA Effects: Because Environmental Commitments 3, 4, 6–12, 15, and 16 present no new sources of trace metals to the affected environment, the effects on trace metal concentrations from implementing these Environmental Commitments are determined to be not adverse.

CEQA Conclusion: Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP Export Service Areas, because they present no new sources of trace metals to the affected environment. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

As described for Alternative 4 (see Section 8.3.3.9), the operation of the water conveyance facilities under Alternative 5A is expected to have a minimal effect on TSS and turbidity levels in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas relative to Existing Conditions and the No Action Alternative (ELT and LLT). This is because the factors that would affect TSS and turbidity levels in the surface waters of these areas would be the same. TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water. Within the Delta, TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of inflows (and associated sediment load), as well as fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water. These factors would be similar under Alternative 5A and Alternative 4, are expected to be minimally different from Existing Conditions and the No Action Alternative (ELT and LLT). Because Alternative 5A is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative (ELT and LLT), Alternative 5A also is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

NEPA Effects: Because TSS concentrations and turbidity levels are expected to be minimally affected relative to the No Action Alternative (ELT and LLT), the effects on TSS and turbidity from implementing Alternative 5A are determined to not be adverse.

CEQA Conclusion: As described for Alternative 4 (see Section 8.3.3.9) changes in river flow rate and reservoir storage that would occur under Alternative 5A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 5A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of Environmental Commitments 3, 4, 6–12, 15, and 16

***NEPA Effects*:** Localized, temporary changes in TSS and turbidity could occur associated with the restoration actions of Environmental Commitments 3, 4, 6–12, 15, and 16. However, these changes would be gradual and not expected to substantially differ from No Action Alternative (ELT and LLT) conditions. Therefore, the effects on TSS and turbidity from implementing these Environmental Commitments are determined to be not adverse.

***CEQA Conclusion*:** It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of Environmental Commitments 3, 4, 6–12, 15, and 16 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor CWA Section 303(d) listed constituents. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities for the Water Conveyance Facilities and Environmental Commitments

The potential construction-related water quality effects that would occur under Alternative 5A would similar to the effects described for Alternative 4A (see Section 8.3.4.2). This is because the type, size, and number of construction activities for water conveyance facilities and Environmental Commitments that would occur under Alternative 5A would be similar to Alternative 4A. The construction-related activities for the water conveyance facilities under Alternative 5A would be similar to those described for Alternative 4A. However, there would be less construction activity due to the fewer intakes constructed and the area of in-water habitat restoration activities implemented under Alternative 5A would be less.

NEPA Effects: The types and magnitude of potential construction-related water quality effects associated with implementation of Alternative 2D would be very similar to the effects discussed for Alternative 4A. Nevertheless, the construction of water supply facilities and Environmental Commitments, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and other agency permitted construction requirements, would result in the potential water quality effects being largely avoided and minimized. The specific Environmental Commitments that would be implemented under Alternative 5A would be similar to those described for Alternative 4A. Consequently, relative to the No Action Alternative (ELT), Alternative 5A would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP/CVP Export Service Areas. Therefore, with implementation of environmental commitments presented in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 5A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP/CVP Export Service Areas. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or CWA Section 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause CWA Section 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Adverse effects from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under Alternative 5A or the No Action Alternative (ELT and LLT). Consequently, any modified reservoir operations under Alternative 5A are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative (ELT and LLT).

Delta

During the June through October period when *Microcystis* blooms occur in the Delta, it is a combination of flows, associated residence time, and water temperatures that are believed to most influence *Microcystis* bloom formation.

Under Alternative 5A, a portion of the Sacramento River water which is conveyed through the Delta to the south Delta intakes under Existing Conditions would be replaced at various locations throughout the Delta by other source water due to diversion of Sacramento River water at the north Delta intakes. The changes in flow paths of water through the Delta and change in operation of the south Delta pumps that would occur due to facilities operations and maintenance of Alternative 5A could result in localized increases in residence time in various Delta sub-regions and decreases in residence time in other areas. Because there is no published analysis of the relationship between *Microcystis* occurrence and residence time, there is uncertainty on how increased residence times may affect *Microcystis* occurrences (ICF International 2016). Further,, in general, there is substantial uncertainty regarding the extent that facilities operations and maintenance of Alternative 5A would result in a net increase in water residence times at various locations throughout the Delta, relative to Existing Conditions. In addition to the effects of operations and maintenance of Alternative 5A, increases in water residence times are expected occur due to separate factors and actions concurrent with the alternative, including habitat restoration (8,000 acres of tidal habitat restoration and enhancements in the Yolo Bypass) and sea level rise due to climate change.

To ensure project operations do not create increased *Microcystis* blooms in the Delta, water flow through Delta channels can be managed through real-time operations particularly the balancing of the north and south Delta diversions. By operating the south Delta pumps more frequently during periods conducive to increased *Microcystis* blooms, residence times can be managed to decrease the potential for blooms to develop, and thus decrease potential microcystin increases due to project operations. As such, effects of Alternative 5A on *Microcystis* levels, and thus microcystin concentrations in the Delta, would not be made more adverse relative to Existing Conditions and the No Action Alternative (ELT and LLT).

Water temperature is also a critical parameter that has been related to *Microcystis* blooms in the Delta. Since Delta water temperatures are largely driven by air temperature, climate change that increases air temperatures relative to Existing Conditions would be expected to increase ambient water temperatures in the Delta by 1.3–2.5°F. These climate changes in the ELT are expected to occur in the Delta under the No Action Alternative, relative to Existing Conditions. Alternative 5A operations and maintenance is not expected to cause increased Delta water temperatures, relative to Existing Conditions or the No Action Alternative.

In summary, increased frequency and magnitude of *Microcystis* blooms may occur in the Delta in the future, relative to Existing Conditions, due to factors unrelated to the project alternative, including: 1) increased residence times resulting from restoration activities and climate change-related sea level rise and 2) climate change-related increased Delta water temperatures. If *Microcystis* occurrences did increase in certain sub-regions of the Delta in the future, there would also be the potential for increased microcystin presence in the Delta, relative to Existing Conditions. To ensure project operations under Alternative 2D do not create significant increases in *Microcystis* blooms in the Delta, that may be associated with increased residence times, water flow through Delta channels would be managed through real-time operations.

SWP/CVP Export Service Area

As described above for the Delta, source waters to the south Delta intakes could be adversely affected relative to Existing Conditions by *Microcystis* both from an increase in Delta water temperatures associated with climate change, and from an increase in water residence times. The impacts from increased Delta water residence times would be primarily related to habitat restoration (8,000 acres of tidal habitat restoration and enhancements in the Yolo Bypass) that is assumed to occur separate from Alternative 5A. The combined effect of these factors on the potential for *Microcystis* blooms in source waters to the south Delta intakes is expected to be much greater than the influence of operations and maintenance of Alternative 5A, the effects of which will be mitigated through real time operations. Increases in ambient air temperatures due to climate change relative to Existing Conditions are expected under this alternative. Increases in ambient air temperatures are expected to result in warmer ambient water temperatures, and thus conditions more suitable to *Microcystis* growth, in the water bodies of the SWP/CVP Export Service Areas. The incremental increase in long-term average air temperatures would be less at the ELT (2.0°F), compared to the LLT (4.0°F).

As discussed in the Delta section above, Alternative 5A is not expected to substantially adversely affect by *Microcystis* blooms, relative to Existing Conditions and the No Action Alternative (ELT and LLT). Additionally, residence time and water temperature conditions in the SWP/CVP Export Service Areas are not expected to become more conducive to *Microcystis* bloom formation due to the operations and maintenance of Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT), because water residence times are projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change not due to Alternative 2D.

NEPA Effects: Modified reservoir operations under Alternative 5A are not expected to promote *Microcystis* production upstream of the Delta, relative to the No Action Alternative (ELT and LLT). Similarly, operations and maintenance of Alternative 5A is not expected to substantially increase water residence times or ambient water temperatures in the Delta, including at the Banks and Jones pumping plants, and thus is not expected to result in adverse effects on *Microcystis* in the Delta, relative to No Action Alternative (ELT and LLT). Lack of adverse effects on *Microcystis* in the Delta would mean that Delta waters diverted into the SWP/CVP Export Service Areas would not be adversely affected. Finally, the potential for *Microcystis* bloom formation within the SWP/CVP Export Service Area water bodies and canals would not be expected to change substantially, if at all, because water residence times are not projected to increase in the SWP/CVP Export Service Areas and any temperature increases there would be due to climate change and not due to Alternative 5A. Thus, the effects on *Microcystis* in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas from implementing Alternative 5A are determined to be not adverse.

CEQA Conclusion: Modified reservoir operations under Alternative 5A are not expected to promote *Microcystis* production upstream of the Delta, relative to the Existing Conditions. Increased frequency and magnitude of *Microcystis* blooms may occur in the Delta in the future, relative to Existing Conditions, due to increased residence times resulting from restoration activities unrelated to the project alternative, as well as climate change and sea level rise that are expected to increase Delta water temperatures. Such increases in residence time and water temperatures would not be caused by implementation of Alternative 5A. Operations and maintenance of Alternative 5A, including the use of real-time operations, are not expected to result in flow and temperature conditions in the Delta, including at the Banks and Jones pumping plants, that would cause substantial increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms. As such, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas of the Delta would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Microcystin, the toxin produced by *Microcystis,* is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences due to climate change and sea level rise may lead to increased microcystin presence in the Delta, relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation may occur and, thus, impacts on beneficial uses could occur, these impacts are not related to implementation of Alternative 5A. Although there is uncertainty regarding this impact, the effects on *Microcystis* from implementing water conveyance facilities are determined to be less than significant. No mitigation is required.

Impact WQ-33: Effects on *Microcystis* Bloom Formation Resulting from Environmental Commitments

Effects on *Microcystis* from implementation of Environmental Commitments under Alternative 5A would be the same as those described for Alternative 4A.

NEPA Effects: Based on the discussion for Impact WQ-33 in Section 8.3.4.2, the effects on *Microcystis* from implementing Environmental Commitments 3, 4, 6–12, 15, and 16 are determined to be not adverse.

CEQA Conclusions: Based on the discussion for Impact WQ-33 in Section 8.3.4.2, Environmental Commitments 3, 4, 6–12, 15, and 16 would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment.

Microcystis and microcystins are not CWA Section 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. However, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta would occur at the early long-term for reasons unassociated with implementation of the Environmental Commitments, including tidal habitat restoration. Further, microcystin is bioaccumulative in the Delta foodweb (Lehman 2010). Thus, potential increases in *Microcystis* occurrences may lead to increased microcystin presence in the Delta relative to Existing Conditions. This has potential to cause microcystins to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose health risks to fish, wildlife or humans. While long-term water quality degradation related to microcystins levels may occur and, thus, significant impacts on beneficial uses could occur, these impacts are not related to implementation of the Environmental Commitments. Therefore, the effects on *Microcystis* from implementing the Environmental Commitments are determined to be less than significant. No mitigation is required.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance and Environmental Commitments

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 5A would have a less-than-significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Bromide
- Chloride
- DOC
- DO
- Pathogens
- Pesticides
- Trace metals
- Turbidity and TSS
- *Microcystis*

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. Chloride, DOC, and bromide concentrations also are of concern in drinking water supplies. However, waters in the San Francisco Bay are not designated to support MUN and AGR beneficial uses. Changes in Delta DO, pathogens, pesticides, trace metals, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Changes in *Microcystis* would be primarily due to factors unassociated with the project alternative. Thus, changes in boron, bromide, chloride, DOC, DO, pathogens, pesticides, trace metals, turbidity and TSS, and *Microcystis* in Delta outflow associated with implementation of Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT) are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay, as described for Alternative 4 (see Section 8.3.3.9).

Elevated EC is of concern for its effects on the AGR beneficial use and fish and wildlife beneficial uses. San Francisco Bay does not have an AGR beneficial use designation. As described for Alternative 4, salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. However, the changes in Delta outflow due to Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Also, as described for Alternative 4, changes in nutrient loading would not be expected to contribute to adverse effects to beneficial uses. Changes in nitrogen (ammonia and nitrate) loading to Suisun and San Pablo Bays under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT), would not adversely impact primary productivity in these embayments because light limitation and grazing currently limit algal production in these embayments. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay. The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. As described for Alternative 4, any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary. Therefore, changes in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay, relative to Existing Conditions and the No Action Alternative (ELT and LLT), shown in Appendix 8O, *San Francisco Bay Analysis*, Table 8O-1, are not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Similar to Alternative 4, loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 5A, relative to Existing Conditions and the No Action Alternative (ELT and LLT) (Appendix 8O, *San Francisco Bay Analysis*, Tables 8O-2). Also, there would be no incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions under this alternative (Appendix 8O, Table 8O-3).

NEPA Effects: Based on the discussion above, Alternative 5A, relative to the No Action Alternative (ELT and LLT), would not cause further degradation to water quality with respect to boron, bromide, chloride, DO, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, turbidity and TSS, or *Microcystis* in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, effects on the San Francisco Bay from implementation of water conveyance facilities and Environmental Commitments 3, 4, 6–12, 15, and 16 are considered to be not adverse.

CEQA Conclusion: As with Alternative 4, Alternative 5A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment.

Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in DO, pathogens, pesticides, trace metals, turbidity or TSS, and *Microcystis* are anticipated in the Delta due to the implementation of Alternative 5A, relative to Existing Conditions, therefore, no substantial changes to these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would be two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow and thus, have minimal influence on salinity changes. Changes in nutrient load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. As with Alternative 4, the change in mercury and methylmercury load (which is based on source water and Delta outflow), relative to Existing Conditions, would be within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA Section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Similarly, based on Alternative 4 estimates, the increase in selenium load would be minimal, and total and dissolved selenium concentrations would be expected to be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the change in selenium load is not expected to contribute to water quality degradation, or make the CWA Section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

8.3.5 Cumulative Analysis

The cumulative effects analysis for water quality considers past, present, and reasonably foreseeable projects or programs in combination with the effects of the project alternatives. This assessment discusses only water quality constituents which could be affected, in part, from construction and implementation of the project alternatives. Constituents or constituent groups which could not be affected by the project alternatives are identified and addressed in the water quality Screening Analysis presented in Appendix 8C. The majority of the constituents assessed in the Screening Analysis have not been detected in the major source waters to the Delta, and others that have been detected have generally not exceeded water quality objectives/criteria or would not be affected by construction and implementation of the project alternatives. Consequently, they are not specifically addressed in this cumulative assessment. For a discussion of cumulative effects related to water temperature, see Chapter 11, *Fish and Aquatic Resources*.

Table 8-76. Effects on Water Quality from the Programs, Projects, and Policies Considered for Cumulative Analysis

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
Regulatory-, Discharge-, and Source Control-Related Actions				
Sacramento Regional County Sanitation District	SRWTP Facility Upgrade Project (EchoWater Project)	Final Environmental Impact Report certified September 2014; construction has been initiated	Upgrade existing secondary treatment facilities to advanced unit processes including improved nitrification/denitrification and filtration.	Reduced discharge concentration and mass of many constituents in wastewater to Sacramento River.
Sacramento County, Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova	Sacramento Stormwater Quality Partnership	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Sacramento River.
San Joaquin County, Stockton, Tracy, and the State Water Resources Control Board	San Joaquin County, Stockton, and Tracy Stormwater Management Programs	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to San Joaquin River.
Yolo County, Public Works Division	Yolo County Stormwater Management Program	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Yolo Bypass.
Central Valley Water Board	Irrigated Lands Regulatory Program	Ongoing and future actions	Prevent agricultural discharges from impairing the waters that receive runoff.	Reduced discharge concentration and mass of many constituents in agricultural drainage to the Delta and tributaries.
Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Grassland Bypass Project, 2010-2019	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Agricultural Drainage Selenium Management Program Plan	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
California Department of Water Resources and Bureau of Reclamation	Franks Tract Project	Proposed	Proposed operable gates to control channel flows at key locations to reduce sea water intrusion.	Goal is reduced western Delta salinity.
Central Valley Water Board	Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
Central Valley Water Board	Total Maximum Daily Load for Selenium in the Lower San Joaquin River	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
Central Valley Water Board	San Joaquin River Selenium TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
Central Valley Water Board	Central Valley Pesticide TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pesticides.
Central Valley Water Board	Salt and Boron TMDL for the Lower San Joaquin River	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of salts and boron.
Central Valley Water Board	Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch TMDL for Mercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	Clear Lake Mercury TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	American River TMDL for Methylmercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	Central Valley Organochlorine Pesticide TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of legacy organochlorine pesticides.
Central Valley Water Board	Central Valley Diuron TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diruon pesticide.
Central Valley Water Board	Central Valley Pyrethroid Pesticides TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pyrethroid pesticides.
Central Valley Water Board	Stockton Urban Waterbodies Pathogen TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pathogens in urban stormwater runoff.

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
Bureau of Reclamation, U.S. Fish and Wildlife Service, and California Department of Water Resources	Biological Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (Delta smelt)	Ongoing and future actions	Regulatory program and actions for CVP/SWP water supply operations for recovery of Delta smelt population. Actions include habitat, flow, and water quality management.	Actions may affect seasonal and long-term Delta water quality conditions.
U.S. Department of Commerce, National Marine Fisheries Service, Bureau of Reclamation, and California Department of Water Resources	Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project	Ongoing and future actions	Regulatory program and actions for CVP/SWP water supply operations for recovery of special-status anadromous fish. Actions include habitat, flow, and water quality management.	Actions may affect seasonal and long-term Delta water quality conditions.
Restoration Actions				
California Department of Fish and Wildlife	Ecosystem Restoration Program Conservation Strategy		Actions to address the critical environmental conditions in the Delta and Suisun Marsh/Bay including Delta flows and habitat restoration.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Bureau of Reclamation, and Suisun Marsh Charter Group	Suisun Marsh Habitat Management, Preservation, and Restoration Plan	Ongoing	Seasonal wetland and tidal marsh restoration actions in Suisun Marsh.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Water Resources	Dutch Slough Tidal Marsh Restoration Project	Final Environmental Impact Report, September 2014	Seasonal wetland and tidal marsh restoration actions in western Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Water Resources and Department of Fish and Wildlife	Cache Slough Area Restoration	Ongoing and future actions	Enhancement and restoration of existing and potential open water, marsh, floodplain and riparian habitat in northern Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
Reclamation District 2093	Liberty Island Conservation Bank	Future	Tidal marsh restoration project in northern Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
California Department of Water Resources	California Water Action Plan	Initiated in January 2014	This plan lays out a roadmap for the next 5 years for actions that would fulfill 10 key themes. In addition, the plan describes certain specific actions and projects that call for improved water management throughout the state.	Actions implemented may affect seasonal and long-term Delta water quality conditions.
Delta Conservancy	California EcoRestore	Initiated in 2015	This program will accelerate and implement a suite of Delta restoration actions for up to 30,000 acres of fish and wildlife habitat by 2020.	Potential for effects on water quality at various Delta locations related to changes in hydrodynamics near restoration actions.

8.3.5.1 Cumulative Effects of the No Action Alternative

Water quality conditions upstream of the Delta, in the Delta Region, and in the SWP/CVP export service areas of the affected environment are expected to change as a result of past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations (e.g., completion of TMDLs, adoption of new or more restrictive criteria/objectives). Many past, present, and reasonably foreseeable future projects are identified and described in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and specific projects or regulatory programs that are either ongoing or proposed for future implementation, and thus, could affect future cumulative water quality conditions, are listed in Table 8-76. The combined water quality effects of projects considered in the cumulative condition will vary, including potential contribution to the degradation of various water quality parameters, whereas others will function to improve constituent-specific water quality in certain areas. Future population growth may produce increased constituent loadings to the water bodies of the affected environment through increased urban stormwater runoff, increased POTW discharges, and changes in land uses. Climate change is anticipated to cause salinity increases in the western and southern Delta due to sea level rise. This is evidenced by the increase in violations of the Bay-Delta WQCP electrical conductivity objective in the Sacramento River at Emmaton under the No Action Alternative, relative to Existing Conditions, as described in Section 8.3.3.1. Conversely, changes in water quality regulations generally are in a direction that will result in improvements in water quality (e.g., increased monitoring and restrictions on urban stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments through improved water quality, more restrictive regulations on POTW discharges, new and/or more restrictive water quality criteria/objectives in Basin Plans).

Some water quality constituents are at levels under Existing Conditions that cause some impact to beneficial uses. These include:

- Bromide
- Chloride

- Electrical Conductivity
- Mercury
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Under the cumulative No Action Alternative, even with consideration of the factors that will affect water quality discussed above, these constituents are expected to remain at levels that will cause some impact to beneficial uses. In addition, the frequency, magnitude, and geographic extent of *Microcystis* blooms in Delta waters may increase in the future as Delta water temperatures increase due to climate change. Thus, for the purposes of NEPA, water quality conditions for the constituents listed above, and possibly for *Microcystis* blooms in Delta waters as well, under the cumulative No Action Alternative constitute an adverse environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is not adverse.

Although the constituents listed above are at levels under Existing Conditions that cause some impact to beneficial uses, the only constituents for which the cumulative effects of the No Action Alternative are expected to adversely affect beneficial uses, relative to Existing Conditions, are electrical conductivity, chloride, and possibly *Microcystis* blooms in Delta waters, due to the effects of climate change and sea level rise. Thus, for the purposes of CEQA, water quality conditions for electrical conductivity chloride, and *Microcystis* blooms in Delta waters under the cumulative No Action Alternative constitute a significant environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is less than significant, relative to Existing Conditions.

8.3.5.2 Concurrent Project Effects

The constituent assessments of the BDCP alternatives evaluated the effects of the water conveyance facilities, plus the hydrodynamic effects of CM2 and CM4, separately from the effects of CM2–CM21. Similarly, the constituent assessments for Alternatives 4A, 2D, and 5A evaluated the effects of the water conveyance facilities separately from the effects of the Environmental Commitments. This section discusses the potential for the concurrent implementation of the water conveyance facilities with the other conservation measures/Environmental Commitments under the action alternatives to result in more substantial effects to water quality than identified in the separate constituent assessments of these project components. This discussion is organized according to the geographic regions of the affected environment—Upstream of Delta, Delta Region, SWP/CVP Export Service Areas—because implementation of the project components differs in these areas. For the SWP/CVP Export Service Areas region of the affected environment (e.g., south of Delta and North Bay Aqueduct) the discussion of concurrent water quality effects is based on water quality changes in the Delta at the export pumping plants, because no conservation measures/Environmental Commitments would be implemented in this portion of the affected environment.

Upstream of the Delta

BDCP Alternatives

In areas upstream of the Delta, the conservation measures or components of these measures that would be implemented in addition to the water conveyance facilities would be: 1) *CM2 Yolo Bypass*

FIsheries Enhancement, 2) *CM18 Conservation Hatcheries*, and 3) *CM19 Urban Stormwater Treatment*. CM2 is not expected to alter water quality in the Sacramento River, as the measure is primarily to improve fish habitat through modifications to Fremont Weir to increase the frequency, duration and magnitude of floodplain inundation in the bypass. CM18 involves the operation of a new fish hatchery, discharges from which would be required to meet NPDES permit requirements to protect water quality and beneficial uses. CM19 may involve actions to improve stormwater quality coming from urban areas outside the Delta, but that drain to Delta waters, and would result in either no effect or beneficial effects on water quality upstream of the Delta. All other conservation measures would be implemented in the Delta region. Maintenance activities associated with the physical structures would not result in substantial, adverse effects on water quality. Consequently, the concurrent implementation of the water conveyance facilities and restoration activities under the BDCP alternatives would not result in new, more adverse effects/significant impacts to water quality beyond those described in the separate impact assessments for these alternatives.

Alternatives 4A, 2D, and 5A

None of the conservation measures discussed for the BDCP alternatives for the upstream of Delta region would be implemented as components of Alternatives 4A, 2D, and 5A, and no Environmental Commitments would be implemented in this region. Consequently, the concurrent implementation of the water conveyance facilities and Environmental Commitments under Alternatives 4A, 2D, and 5A would not result in new, more adverse effects/significant impacts on water quality beyond those described in the separate impact assessments for these alternatives.

Delta and SWP/CVP Export Service Areas

BDCP Alternatives

The water quality assessment for the Delta region concluded that the separate impacts of the water conveyance facilities and CM2–CM21 under the BDCP alternatives would not be adverse/would be less than significant for ammonia, boron, DO, nitrate+nitrite, pathogens, phosphorus, trace metals, and turbidity/TSS. For water quality conditions of these constituents to be adverse/ significant under the concurrent implementation of the water conveyance facilities and CM2–CM21 would require that CM2–C21 implementation contribute additional loading of these constituents or otherwise alter conditions beyond the hydrodynamic effects of the water conveyance facilities to result in adverse conditions. However, when considered concurrently, CM1–CM21 are not expected to result in new, previously unidentified adverse/significant impacts, relative to the individual impact determinations, for the reasons provided below.

- **Ammonia:** Ammonia concentrations under the water conveyance facilities will be lower in the Delta due to lower Sacramento River concentrations resulting from a separate project being implemented by the Sacramento Regional County Sanitation District, which will result substantially reduced ammonia discharges from the Sacramento Regional Wastewater Treatment Plant. CM2–CM21 are not expected to substantially alter ammonia concentrations in the affected environment. Thus, concurrent implementation of CM1–CM21 would not result in adverse ammonia conditions.

- **Boron and Trace Metals:** CM2–CM21 would not present new or substantially changed sources of boron or trace metals in the Delta. Thus, their concurrent implementation with CM1 would not result in adverse boron and trace metals conditions.

- **DO:** DO conditions under the water conveyance facilities are expected to be similar to Existing Conditions, and CM2–CM21 are not expected to contribute oxygen-demanding substances at levels that would adversely affect DO levels. Further, CM14 would contribute to improving DO conditions in the Stockton Deep Water Channel. Thus, concurrent implementation of CM1–CM21 would not result in adverse DO conditions.
- **Nitrate+nitrite:** Long-term average nitrate+nitrite concentrations are anticipated to remain low with implementation of the water conveyance facilities. CM2–CM21 would not present new or substantially changed sources of nitrate+nitrite in the Delta. Conversely, it is expected there may be a decrease in nitrate+nitrite concentrations as lands used for agriculture are converted for restoration, thus reducing fertilizer application on these lands. Thus, their concurrent implementation with the water conveyance facilities would not result in adverse nitrate+nitrite conditions.
- **Pathogens:** Pathogens conditions under the water conveyance facilities are expected to be similar to Existing Conditions. Thus, its concurrent implementation with the restoration activities would not make pathogens conditions adverse.
- **Phosphorus:** The water conveyance facilities are not expected to substantially change phosphorus concentrations, because concentrations in Delta source water are similar throughout the year. The restoration activities are not anticipated to contribute additional phosphorus load. Thus, concurrent implementation of the water conveyance facilities with the restoration activities would not result in adverse phosphorus conditions.
- **Turbidity/TSS:** Turbidity/TSS conditions under the water conveyance facilities are expected to be similar to Existing Conditions. Thus, its concurrent implementation with the restoration activities would not make turbidity/TSS conditions adverse.

The assessment of bromide, chloride, and EC conditions in the Delta concluded that CM1 plus the hydrodynamic effects associated with CM2 and CM4 under the BDCP alternatives would result in an adverse effect/significant and unavoidable impact, to varying degrees. Implementation of CM2–CM21 would not present new or substantially changed sources of these constituents in the Delta beyond the effects on hydrodynamics. Thus, their concurrent implementation with CM1 would not result in more adverse/significant bromide, chloride, and EC conditions than has been described for the separate conservation measures.

The assessment of dissolved organic carbon (DOC) conditions in the Delta concluded that implementation of CM1 of Alternatives 1A–3, 4, or 5 would not result in an adverse effect/significant impact, whereas, implementation of CM2–CM21 under these alternatives would result in an adverse/significant and unavoidable impact associated with the creation of the restoration areas. Concurrent implementation of CM1 with CM2–CM21 under Alternatives 1A–3, 4, or 5 is not expected to result in more adverse/significant impacts than described for the separate conservation measures, because the long-term average DOC increases resulting from CM1 would be comparatively small and within the uncertainty in the contributions that would result from the restorations areas. Conversely, the assessment of CM1 under Alternatives 6A–9 concluded significant and unavoidable impacts for DOC. The adverse/significant conditions under CM1 concurrent with the conditions anticipated for CM2–CM21 may be more adverse/significant than when considered separately, particularly because the projected long-term average DOC increases under CM1 would be a measurable, additive contribution.

The assessment of pesticide conditions in the Delta concluded that implementation of CM1 under Alternatives 1A–3, 4, or 5 would not result in an adverse effect/significant impact, whereas Alternatives 6A–9 would result in significant and unavoidable impacts for pesticides, because of potential adverse increases at Franks Tract, Rock Slough, and Contra Costa Pumping Plant No. 1. The assessment of CM2–CM21, for all alternatives, identified an adverse/significant and unavoidable impact associated with *CM13 Invasive Aquatic Vegetation Control*. However, concurrent implementation of CM1 with CM2–CM21, under all BDCP alternatives, is not expected to result in more adverse/significant impacts than described for the separate conservation measures, because the effects of CM13 would primarily occur in the vicinity of pesticide application, and mitigation is proposed to apply pesticides in a manner that minimizes the risk to human health, non-target organisms, and the aquatic ecosystem.

The assessment of mercury conditions in the Delta concluded that implementation of CM1 under Alternatives 1A–3, 4, or 5 would not result in an adverse effect/significant impact, whereas, implementation of CM2–CM21 under these alternatives would result in an adverse/significant and unavoidable impact associated with the creation of the restoration areas. Concurrent implementation of CM1 with CM2–CM21 under Alternatives 1A–3, 4, or 5 is not expected to result in more adverse/significant impacts than described for the separate conservation measures, because the mercury conditions in water and fish resulting from CM1 would be similar to Existing Conditions. Conversely, the assessment of CM1 under Alternatives 6A–9 concluded significant and unavoidable impacts for mercury. The adverse/significant conditions under CM1 concurrent with the conditions anticipated for CM2–CM21 may be more adverse/significant than when considered separately, particularly because of the bioaccumulative properties of mercury and because the Delta is already impaired due to elevated mercury.

The assessment of selenium conditions in the Delta concluded that implementation of CM1 under Alternatives 1A–3, 4, or 5 would not result in an adverse effect/significant impact, whereas conditions under Alternatives 6A–9 would be adverse/significant and unavoidable. Selenium conditions resulting from implementation of CM2–CM21 under all BDCP alternatives were determined to not be adverse/less than significant. Of concern for selenium is increased exposure of aquatic organisms through increased water residence time and selenium concentrations. However, the impact assessment concluded that CM2–CM21 would not contribute substantially to these conditions, because factors would also be in place to minimize selenium exposure, including TMDLs to reduce loading to the system, wetland design to prevent buildup of selenium in restoration areas, and implementation of *AMM27 Selenium Management* (see Appendix 3.C, *Avoidance and Minimization Measures*, of the BDCP). Thus, concurrent implementation of CM1 and CM2–CM21 is not anticipated to result in more adverse/significant impacts than has been described for the separate conservation measures.

The assessment of *Microcystis* conditions in the Delta concluded that CM1 plus the hydrodynamic effects associated with CM2 and CM4 under the BDCP alternatives would result in an adverse effect/significant impact. Effects of CM2–CM21, beyond the increase in residence time and localized water temperature described in the separate impacts assessments, would not present new, previously unidentified impacts. Thus, concurrent implementation of CM1–CM21 would not result in more adverse/significant *Microcystis* conditions than has been described for the separate conservation measures.

Alternatives 4A, 2D, and 5A

The water quality assessment for the Delta region concluded that the separate impacts of the water conveyance facilities and Environmental Commitments under Alternatives 4A, 2D, and 5A would not be adverse/would be less than significant for ammonia, boron, bromide, chloride, DO, nitrate+nitrite, dissolved organic carbon, pathogens, pesticides, phosphorus, selenium, trace metals, turbidity/TSS, and *Microcystis*. For water quality conditions of these constituents to be adverse/ significant under the concurrent implementation of the water conveyance facilities and Environmental Commitments would require that the Environmental Commitments implementation contribute additional loading of these constituents or otherwise alter conditions beyond the hydrodynamic effects of the water conveyance facilities to result in adverse conditions. However, when considered concurrently, the water conveyance facilities and Environmental Commitments are not expected to result in new, previously unidentified adverse/significant impacts, relative to the individual impact determinations.

As described above for the BDCP alternatives, ammonia concentrations under the non-HCP alternatives' water conveyance facilities would be lower in the Delta, and the Environmental Commitments are not expected to substantially alter ammonia concentrations in the affected environment. Thus, concurrent implementation of the water conveyance facilities and Environmental Commitments would not result in adverse ammonia conditions.

Similarly, the Environmental Commitments would not present new or substantially changed sources of boron, bromide, chloride, DO-consuming substances, nitrate+nitrite, pathogens, pesticides, phosphorus, trace metals, or turbidity/TSS in the Delta. Thus, their concurrent implementation with water conveyance facilities would not result in adverse conditions for these constituents.

The assessment of EC conditions in the Delta concluded that water conveyance facilities under Alternatives 4A, 2D, and 5A would result in not adverse/less than significant impacts with implementation of identified mitigation measures. Implementation of Environmental Commitments would not present new or substantially changed sources of salinity-related constituents in the Delta that would affect EC levels. Thus, their concurrent implementation with water conveyance facilities would not result in more adverse/significant EC conditions than has been described for the separate project components.

The assessment of mercury conditions in the Delta concluded that the water conveyance facilities under Alternatives 4A, 2D, and 5A would not result in an adverse effect/significant impact, whereas, implementation of Environmental Commitments under these alternatives would result in an adverse/significant and unavoidable impact associated with the creation of the restoration areas. Concurrent implementation of water conveyance facilities with the Environmental Commitments is not expected to result in more adverse/significant impacts than described for the separate project components, because the mercury conditions in water and fish resulting from water conveyance facilities would be similar to Existing Conditions.

8.3.5.3 Cumulative Effects of the Action Alternatives

When the effects of the action alternatives on water quality are considered in connection with the potential effects of past, present, and reasonably foreseeable projects or programs, the potential cumulative effects on water quality range from beneficial to potentially adverse, depending upon water quality constituent/parameter and location. This cumulative analysis thus follows the list approach outlined in CEQA guidelines 15130(b)(1), the list including the defined past, present, and foreseeable actions in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and in particular the future potential actions listed in Table 8-76.

If the cumulative water quality condition (which includes implementation of the action alternative along with past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations) for a constituent or group of constituents within a defined region of the affected environment is determined not to be adverse for the purposes of NEPA compliance (or less than significant under CEQA), then no further assessment is conducted. No further assessment is conducted because a cumulative condition that is non-adverse (NEPA terminology) or less than significant (CEQA terminology) demonstrates that the action alternative would not have adverse effects that are individually minor but that would "cumulate" or "be additive" with those of other past, present, and reasonably foreseeable projects to result in an adverse (significant) cumulative effect.

Conversely, if the cumulative water quality condition for a particular constituent is determined to be adverse for NEPA purposes or significant for CEQA purposes, then further assessment is conducted. For compliance with State CEQA Guidelines Section 15130, further assessment is provided to determine if implementation of the action alternatives would contribute considerably to that significantly impacted cumulative condition. If implementation of an action alternative would not contribute considerably to the significantly impacted cumulative water quality condition identified, then no further mitigation is required. However, if implementation of an action alternative would contribute considerably to the adverse (significant) cumulative water quality condition identified, then mitigation for the action alternative's cumulatively considerable contribution to the identified adverse (significant) cumulative water quality condition is proposed (if any is at least potentially feasible). For the purposes of NEPA compliance, the context and intensity of the potential action alternative-related contribution to any adverse (significant) cumulative condition is evaluated and mitigation measures are identified that would reduce or minimize the action alternative's contribution to the cumulative impact.

The potential for cumulative impacts on water quality for the action alternatives is assessed for: 1) construction-related activities, 2) water conveyance facilities operations and maintenance, and 3) implementation of conservation measures/Environmental Commitments for the same geographic scope (Affected Environment) as done for individual action alternatives analyses. Each action alternative is assessed for each of these three impact assessment categories. Effects are specifically discussed by region of the affected environment (i.e., Upstream of the Delta, Delta Region, and SWP/CVP Export Service Areas) and by constituent or constituent groups. Individual discussions for specific action alternatives are provided only if the anticipated effects under one or more action alternatives can be meaningfully distinguished from the effects anticipated under other alternatives. If the contributions of the various action alternatives to a cumulative condition cannot be readily distinguished from one another, then a single assessment that addresses all action alternatives is provided.

Cumulative Impact WQ-1: Cumulative Impacts on Water Quality Resulting from Construction-Related Activities

Upstream of the Delta

BDCP Alternatives

Construction activities upstream of the Delta would be tied to conservation measures for the BDCP alternatives. Conservation measures or components of these measures that would be constructed in areas upstream of the Delta would be: 1) *CM2 Yolo Bypass Fisheries Enhancement* (i.e., the Fremont Weir component of the action), 2) *CM18 Conservation Hatcheries* (i.e., the new hatchery facility), and 3) *CM19 Urban Stormwater Treatment*. Neither the construction to be undertaken nor the techniques and conservation measures to be employed upstream of the Delta would differ sufficiently among alternatives to warrant separate alternative-specific discussions here. Hence, the BDCP alternatives are discussed collectively in this cumulative assessment. Construction of individual components necessitated by CM2, CM18, and CM19 could involve site preparation and earthwork adjacent to water bodies of the affected environment. If so, their construction also would include water quality protection actions in the form of environmental commitments (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*) and related water quality protection actions issued in agency permits required for construction and operation of facilities. Such actions would include SWPPPs that would minimize erosion of soils into water bodies and would minimize/eliminate the direct spilling of earthmoving equipment fuels, oils, and other construction materials into water bodies, thus minimizing any effects on water quality in adjacent water bodies. Other water quality protection actions issued in agency permits would include those in the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), project-specific WDRs or CWA Section 401 water quality certification from the appropriate Central Valley Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. Thus, construction activities associated with the BDCP Alternatives would not contribute considerably to any adverse (significant) cumulative water quality condition upstream of the Delta, nor would construction-related effects make an otherwise non-adverse (significant) cumulative water quality condition adverse in this region.

Alternatives 4A, 2D, and 5A

Alternatives 4A, 2D, and 5A do not include related Environmental Commitments in the upstream of Delta region; thus, the construction-related effects described above for the BDCP alternatives do not apply to these alternatives.

Delta

The construction of new conveyance facilities under all action alternatives, and construction associated with implementing restoration actions, particularly CM2–CM10 under the BDCP alternatives (Environmental Commitments 3, 4, 6, 7, and 9–10 under Alternatives 4A, 2D, and 5A), could result in elevated turbidity/TSS in surface waters adjacent to construction activities due to the erosion of disturbed soils and associated sedimentation entering Delta waterways or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). In addition, the use of heavy earthmoving equipment adjacent to Delta waterways may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment. The extensive construction activities that will be necessary to implement the new conveyance facilities, and CM4–CM10 under the BDCP alternatives (Environmental Commitments 4, 6, 7, and 9–10 under Alternatives 4A, 2D, and 5A) would involve a variety of land disturbances in the Delta including vegetation removal; grading and excavation of soils; establishment of roads-bridges, staging, and storage areas; in-water sediment dredging and dredge material storage; and hauling and placement or disposal of excavated soils and dredge materials. Although the number of intakes to be constructed, pipeline alignments and other construction aspects vary among the action alternatives, all action alternatives involve sufficient construction activities that, if conducted improperly, could adversely affect Delta water quality.

Although action alternatives having greater number of intakes and greater construction activities pose a greater overall potential to adversely affected water quality, adverse water quality effects for all action alternatives will be avoided or reduced to less than substantial levels in the same manner, which is by implementing proper conservation measures and obtaining and abiding by agency-issued permits need for construction activities (e.g., State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), possibly project-specific WDRs, CWA Section 401 water quality certification from the appropriate Central Valley Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits). Because of this commonality among alternatives regarding potential for construction-related water quality effects, and the common means of avoiding or reducing such effects, all action alternatives are assessed collectively rather than individually.

As described for all action alternatives in Sections 8.3.3 and 8.3.4, the implementation of construction-related environmental commitments (Appendix 3B, *Environmental Commitments, AMMs, and CMs*) and abiding by agency-issued permits need for construction activities will reduce potential construction-related water quality impacts in the Delta to less-than-significant levels. Moreover, the cumulative condition for turbidity/TSS and petroleum contaminants in Delta waters are not expected to be adverse. This is due, in large part, to the implementation (or planned implementation) of construction-related environmental commitments (Appendix 3B) and agency permitted construction "best management practices" for construction of not only the selected action alternative (including its conservation measures/Environmental Commitments), but also other past, present, and reasonably foreseeable future projects. Because construction-related effects on all water quality constituents/parameters would be minimized through environmental commitments (Appendix 3B) and permitted construction "best management practices" in the agency-issued permits discussed above, construction activities associated with the action alternatives would not contribute considerably to any adverse (significant) cumulative water quality condition in the Delta, nor would construction-related effects make an otherwise non-adverse (significant) cumulative water quality condition adverse.

SWP/CVP Export Service Areas

Because construction-related activities associated with the action alternatives are not expected to contribute considerably to any adverse (significant) cumulative Delta water quality condition, including conditions at the Banks and Jones pumping plants, which are the primary locations of water export to the SWP/CVP Export Service Areas, the construction of these alternatives would not contribute considerably to any adverse (significant) cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas.

NEPA Effects: The action alternatives involve minimal construction elements upstream of the Delta and would include implementation of construction-related environmental commitments (Appendix 3B, *Environmental Commitments, AMMs, and CMs*) that would mitigate any temporary construction-related effects on water quality. Thus their construction would not adversely affect any cumulative water quality constituent/parameter condition upstream of the Delta. Construction of conveyance facilities and conservation measures/Environmental Commitments for the action alternatives could potentially result in temporary water quality effects on Delta turbidity/TSS levels and petroleum contaminants. However, the cumulative condition for Delta turbidity/TSS and petroleum contaminants would not be adverse for several reasons. First, there is currently no adverse conditions for turbidity/TSS levels and petroleum contaminants in the Delta. Second, implementation of construction-related environmental commitments (Appendix 3B) for the action alternative to be implemented and use of related construction BMPs for other projects would reduce effects on these and other Delta water quality constituents/parameters. Third, because construction-related effects on water quality are temporary in nature, they tend not to be cumulative over time (i.e., construction effects on water quality are not permanent).

CEQA Conclusion. The temporary construction-related effects on water quality resulting from constructing the action alternatives, including conservation measures/Environmental Commitments, would not contribute considerably to any significant cumulative Delta water quality condition, nor would construction-related effects make an otherwise non-adverse cumulative Delta water quality condition for any constituent/parameter potentially significant. Because construction-related activities are not expected to contribute considerably to any significant cumulative Delta water quality condition, they also would not contribute considerably to any sgnificant cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas. No mitigation is required.

Cumulative Impact WQ-2: Cumulative Impacts on Water Quality Upstream of the Delta Resulting from Facilities Operations and Maintenance and Conservation Measures (or Environmental Commitments)

Constituent loading from upstream watersheds and resultant concentrations/levels in the water bodies upstream of the Delta would remain unchanged, or would be negligibly affected, by implementation of facilities operations and maintenance under the action alternatives. Changes in seasonal reservoir storage levels and river flows from altered system-wide operations under the action alternatives would have negligible, if any, effects on water quality in the rivers and reservoirs upstream of the Delta. Consequently, facilities operations and maintenance under any of the action alternatives would not be expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

Conservation measures or components of these measures that would be implemented as part of the BDCP alternatives in areas upstream of the Delta would be: 1) *CM2 Yolo Bypass Fisheries Enhancement*, 2) *CM18 Conservation Hatcheries*, and 3) *CM19 Urban Stormwater Treatment*. CM2 is a fish enhancement measure and, thus, is not expected to alter water quality upstream of the Delta. (Note: Alternatives 4A, 2D, and 5A do not contain Environmental Commitments related to CM2, CM18, or CM19). CM18 involves the operation of a new fish hatchery, discharges from which would be required to meet NPDES permit requirements to protect water quality and beneficial uses. CM19 may involve actions to improve stormwater quality coming from urban areas outside the Delta, but that drain to Delta waters, and would result in either no effect or beneficial effects on water quality upstream of the Delta. All other conservation measures would be implemented in the Delta region.

Maintenance activities associated with the physical structures would not result in substantial, adverse effects on water quality. Consequently, the implementation of CM2–CM21 is not expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

NEPA Effects: Implementation of the action alternatives facilities operations and maintenance, and their associated conservation measures/Environmental Commitments, would have negligible, if any, water quality effects on water bodies of the affected environment located upstream of the Delta. Any negligible effects that may occur would not contribute considerably to any adverse cumulative water quality condition in water bodies upstream of the Delta, nor would the action alternatives effects make an otherwise non-adverse cumulative water quality condition for any constituent/parameter adverse.

CEQA Conclusion. Because the potential effects of facilities operations and maintenance and associated conservation measures/Environmental Commitments on water quality upstream of the Delta would be minimal, implementation of the action alternatives would not contribute considerably to any significant cumulative water quality condition upstream of the Delta, No mitigation is required.

Cumulative Impact WQ-3: Cumulative Impacts on Water Quality in the Delta and SWP/CVP Export Service Areas Resulting from Facilities Operations and Maintenance and Conservation Measures (or Environmental Commitments)

When the effects of implementing any one of the action alternatives on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the potential effects of projects listed in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, and Table 8-76, the cumulative water quality condition in the Delta Region and SWP/CVP Export Service Areas for the following constituents is considered to not be adverse. Additional discussion for these water quality constituents is provided below.

- Ammonia
- Boron
- DO
- Nitrate + Nitrite
- Pathogens
- Phosphorus
- Trace metals
- Turbidity/TSS

Ammonia

Ammonia levels are not expected to be adverse under the cumulative condition as a result of the Sacramento Regional Wastewater Treatment Plant, and other publicly owned treatment works (POTWs) that discharge to the Delta, nitrifying their effluent that is discharged to Delta tributaries and waters.

Boron

The lower San Joaquin River is listed on the State's CWA Section 303(d) list of impaired water bodies for salt and boron (State Water Resources Control Board 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Water Board has prepared a TMDL with an implementation program where it is expected that actions taken to control salts also will control boron as well (Central Valley Water Board 2004). With regulatory actions being taken to improve boron concentrations (and salinity in general on the San Joaquin River), the cumulative condition for boron is considered to not be adverse.

Dissolved Oxygen

DO throughout the Delta is generally suitable for beneficial use protection, with the notable exception of the Stockton Deep Water Ship Channel. The TMDL for DO and related actions (e.g., Stockton Deep Water Ship Channel aeration facility) is expected to further improve DO levels in the future. Thus, DO levels under the cumulative condition are not expected to be adverse.

Nitrate/Nitrite

Similar to ammonia levels, nitrate/nitrite levels in the Delta may be reduced in the future as POTWs discharging to Delta waters implement de-nitrification processes. The Central Valley Water Board is currently permitting such requirements with regularity and thus notable reductions in POTW-related nitrate/nitrite discharges are expected in the future, and other new or greater sources are not anticipated that would offset such point-source reductions. Thus, nitrate/nitrite levels under the cumulative condition are not expected to be adverse.

Pathogens

Similarly, increasingly stringent state regulations on both POTWs and urban runoff through the NPDES program is anticipated to reduce pathogen loading to Delta waters from these sources. As discussed in the project-specific analyses of alternatives, pathogen levels in the Delta are most affected by local factors, primarily local land uses and associated runoff from such lands. Conversion of Delta agricultural lands to tidal wetlands under the action alternatives may alter levels of coliforms and *E. coli* (either up or down), but would be expected to reduce loading of *Cryptosporidium*. Moreover, increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to State and Federal water quality regulations requiring disinfection of effluent discharges and the State's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. The ability of storm water BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading. In sum, Delta pathogen levels are not anticipated to be adverse under the cumulative condition.

Phosphorus

Primary sources of phosphorus to Delta waters include agriculture, municipal POTWs, individual septic treatment systems, urban runoff, stream bank erosion, and decaying plant material. Currently, Delta phosphorous levels are not of substantial concern to state water quality regulatory agencies, nor is there clear evidence that phosphorous levels are adversely affecting Delta beneficial uses. Due to increased regulations and regulatory monitoring anticipated in the future, which may include water quality objectives for phosphorus at some point in the future, loading from agriculture, municipal POTWs, individual septic treatment systems, and urban runoff are all expected to remain at similar levels to that under current conditions, or decline, under the future cumulative condition. Loadings from stream bank erosion and decaying plants are not expected to change notably in the future. Hence, phosphorus levels are not anticipated to be adverse under the cumulative condition.

Trace Metals

Primary sources of trace metals to Delta waters include acid mine drainage (e.g., zinc, cadmium, copper, lead) from abandoned and inactive mines (i.e., Iron Mountain and Spring Creek mines) in the Shasta watershed area, which enter the Sacramento River system through Shasta Lake and Keswick Reservoir, agriculture (e.g., copper and zinc), POTW discharges (e.g., copper, zinc, and aluminum), and urban runoff (e.g., zinc, copper, lead, cadmium). Continued efforts to control acid mine drainage into the Sacramento River system and increasingly stringent regulations are expected in the future. Monitoring and regulatory controls on agricultural runoff, POTW discharges, and urban runoff are anticipated to prevent trace metal concentration under the cumulative condition from becoming adverse.

Turbidity/TSS

Future land use changes could have minor effects on TSS concentrations and turbidity levels throughout the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than substantial levels. Construction activities are closely regulated under construction NPDES permits, which require the preparation of SWPPPs and the implementation of agency permitted construction BMPs that will minimize sedimentation into adjacent water bodies which would, in turn, increase turbidity/TSS. Moreover, construction projects are short-term in nature and thus their effects on turbidity/TSS tend not to be additive among multiple construction activities over time. Consequently, Delta turbidity/TSS levels under the cumulative condition are not expected to be adverse.

Because the cumulative water quality condition in the Delta for the constituents discussed above are considered to not be adverse in the Delta when considering all past, present, and reasonably foreseeable projects and regulatory actions, and because this cumulative condition includes the anticipated effects of implementing the facilities operations and maintenance of any one of the action alternatives, along with their associated conservation measures/Environmental Commitments, none of these alternatives would contribute to an adverse (significant) cumulative condition for these constituents either in the Delta Region or the SWP/CVP Export Service Areas.

Cumulative water quality conditions for the constituents listed below are considered to be adverse, or have reasonable potential to be adverse, in portions of the Delta. Adverse (significant) cumulative water quality conditions for these constituents are expected when the effects of implementing any one of the action alternatives on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the effects of past, present, and reasonably foreseeable projects, including those listed in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*.

- Bromide
- Chloride
- Electrical Conductivity
- Mercury
- *Microcystis* Blooms
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Each of the constituents listed above, for which the cumulative Delta conditions are determined to be adverse, or potentially adverse, are discussed further below to determine whether implementation of the action alternatives would contribute considerably to these adverse (significant) cumulative water quality conditions.

Bromide

The cumulative condition for bromide is considered adverse in the Delta, because of marked increases in bromide concentrations anticipated to occur in the northwest Delta, including at the North Bay Aqueduct intake at Barker Slough. The primary driver of the adverse (significant) cumulative condition is the amount and location of tidal habitat restoration assumed to be implemented as part of the cumulative condition. This tidal habitat restoration would be implemented a component of the BDCP alternatives' conservation measures, or as part of separate actions (e.g., the California Water Action Plan/EcoRestore) for Alternatives 4A, 2D, and 5A, which will affect Delta hydrodynamics. Another contributing factor is sea water intrusion associated with climate change.

Increased bromide concentrations would not be anticipated to occur in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all action alternatives. Therefore, the cumulative condition for bromide in the SWP/CVP Export Service Areas with implementation of any of the alternatives is not expected to be adverse.

BDCP Alternatives

Alternatives 1A–6C and 9, which include up to 65,000 acres of tidal restoration as part of conservation measures, would increase long-term average bromide concentrations at Barker Slough to levels substantially higher than those under Existing Conditions. Alternative 7 would not increase the long-term average bromide concentration at this location, and Alternative 8 would only increase it slightly. However, all alternatives would increase the drought period average bromide concentration at Barker Slough substantially, relative to concentrations during the drought period analyzed under Existing Conditions (Appendix 8E, *Bromide*). Based on their causing substantially increased average bromide concentrations at Barker Slough in the northwest Delta on a long-term average basis and/or during drought periods, implementation of the BDCP alternatives would contribute substantially to the adverse (significant) cumulative condition in the Delta for bromide.

Construction and implementation of the North Bay Aqueduct Alternative Intake Project would provide water from the Sacramento River that is very low in bromide to the existing service area of the North Bay Aqueduct, reducing the potential effects of cumulative bromide concentration increases on water treatment facilities and end-users of water from the North Bay Aqueduct.

Alternatives 4A, 2D, and 5A

The amount of tidal habitat restoration assumed for Alternatives 4A, 2D, and 5A is substantially less than assumed for the BDCP alternatives, such that these alternatives are not expected to significantly affect Delta hydrodynamics and source water fractions. Modeling results (Appendix 8E, *Bromide*) show that long-term and drought period average bromide concentrations with implementation of Alternatives 4A, 2D, and 5A water conveyance facilities, and some assumed habitat restoration, would be similar to or decrease relative to Existing Conditions. Thus, Alternatives 4A, 2D, and 5A would not contribute substantially to the adverse (significant) cumulative condition in the Delta for bromide.

Chloride

The cumulative condition for chloride is considered adverse in the Delta, because of marked increases in chloride concentrations anticipated to occur in the western Delta and potentially Suisun Marsh, One driver of the increased chloride concentrations is the amount and location of tidal habitat restoration to be implemented and assumed as part of the cumulative condition. This tidal habitat restoration would be implemented a component of the BDCP alternatives' conservation measures, or as part of separate actions (e.g., the California Water Action Plan/EcoRestore) for Alternatives 4A, 2D, and 5A, which will affect Delta hydrodynamics. Another contributing factor is sea level rise and intrusion associated with climate change.

The cumulative condition for chloride would not be adverse in the SWP/CVP Export Service Areas due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all action alternatives.

BDCP Alternatives

Regarding the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Antioch and Contra Costa Canal Pumping Plant #1, the modeling and assessment approach indicated that Alternatives 1A–1C, 3, and 7–9 would result in a substantial increase in the frequency of objective exceedance. Regarding the frequency of exceeding the 250 mg/l chloride objective at Antioch, the modeling and assessment approach indicated that Alternatives 1A–1C, 3, and 5 would result in a substantial increase in the frequency of exceeding this objective, relative to Existing Conditions, whereas Alternative 9 would cause only a minor increase in frequency of exceedance and Alternatives 6A–8 would result in a reduction in frequency of exceeding the 250 mg/L chloride objective (Appendix 8G, *Chloride*). Regarding exceedance of Bay-Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation shall continue to monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. These water quality objectives are legally enforceable means of protecting beneficial uses in the Delta, and are and will continue to be included in the Bay-Delta WQCP. This ensures that these commitments are enforceable obligations that will continue to affect operations and protect water quality. DWR and Reclamation have a good history of compliance with water quality objectives (see Sections 8.1.3.4 and 8.1.3.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in Sections 8.3.1.1 and 8.3.1.3), it is likely that any objective exceedance could be avoided through real-time operation of the SWP and CVP. Nevertheless, water quality degradation could occur that may not be addressed through real-time operations. Depending on siting and design of tidal restoration areas, the BDCP alternatives could substantially increase chloride levels in some areas of Suisun Marsh relative to Existing Conditions, primarily during the October through May period. Hence, based on their respective effects on increased chloride levels in Suisun Marsh and the increased water quality degradation in the western Delta, implementation of facilities operations and maintenance under the BDCP alternatives would contribute substantially to this adverse (significant) cumulative condition for chloride. Additionally, implementation of tidal habitat restoration would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse (significant) cumulative condition. Implementation of CM2, CM3, and CM5–CM21 would not contribute substantially to this adverse (significant) cumulative condition.

Alternatives 4A, 2D, and 5A

Implementation of facilities operations and maintenance under Alternatives 4A, 2D, and 5A would not be expected to contribute substantially to the adverse (significant) cumulative condition for chloride, as modeling results show that operations would not contribute to substantial adverse changes in chloride concentrations at modeled Delta locations. Additionally, unlike the BDCP alternatives, implementation of tidal habitat restoration would not be expected to contribute to increased chloride concentrations, because the areal extent of the new restoration area would be a relatively small portion of the existing and planned Delta tidal habitat areas and, thus, not expected to measurably affect the Delta hydrodynamics. As such, implementation of Environmental Commitments associated with these alternatives would not contribute substantially to this adverse (significant) cumulative condition.

Electrical Conductivity

The cumulative condition for EC is considered to be adverse, at various Delta locations and Suisun Marsh, depending on action alternative implemented. One driver of the adverse EC conditions is the amount and location of tidal habitat restoration to be implemented and assumed as part of the cumulative condition. This tidal habitat restoration would be implemented a component of the BDCP alternatives' conservation measures, or as part of separate actions (e.g., the California Water Action Plan/EcoRestore) for Alternatives 4A, 2D, and 5A, which will affect Delta hydrodynamics. Another contributing factor is sea level rise and intrusion associated with climate change.

EC levels at the south Delta export pumps would improve under all alternatives and thus the cumulative EC condition at the export pumps would not be adverse. As such, cumulative EC levels in the SWP/CVP Export Service Areas would not be adverse.

BDCP Alternatives

Alternatives 1A–3 and 5–9 are expected to result in more frequent exceedances of the Bay-Delta WQCP EC objective in the Sacramento River at Emmaton, relative to Existing Conditions. This is due in part to the definition of these alternatives, in which the compliance point is moved from Emmaton to Threemile Slough. Although modeling of Alternative 4 indicated more frequent exceedance of the Emmaton objective as well, these results were for modeling that was originally performed for Alternative 4 assuming the Emmaton compliance point shifted to Threemile Slough, but Alternative 4 now does not include a change in compliance point from Emmaton to Threemile Slough. Sensitivity analyses performed indicated that Alternative 4 is not expected to result in more frequent exceedances of the Emmaton objective, but that water supply and water quality conditions could be either under greater stress or under stress earlier in the year, and salinity EC levels at Emmaton and in the western Delta may increase as a result, leading to EC water quality degradation and increased possibility of impacts adverse effects to agricultural beneficial uses. Similarly, water quality degradation is expected to occur at Emmaton and other areas of the western Delta under all alternatives during parts of the summer, and on an annual average basis for Alternatives 1, 3, 4 Scenarios H1 and H2, and 9. To the extent that exceedances of this objective or substantial water quality degradation is expected, these impacts could lead to effects on agricultural beneficial uses. Increases in EC in the San Joaquin River at San Andreas Landing are expected for parts of the summer under all alternatives, and depending on the nature of the increases, may result in water quality degradation that could lead to effects on agricultural beneficial uses.

Moreover, in the central Delta at Prisoner's Point, Alternatives 2A–C, 4 (Operational Scenarios H1 through H4), and 6A–8 would result in substantially increased frequency of exceedance of the EC objective, whereas Alternative 5 would cause a lesser increase in frequency of exceedance, and Alternatives 1A–C, 3, and 9 would have little to no effect on frequency of exceedance of the EC objective at Prisoner's Point (Appendix 8H). These exceedances could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact.

Alternatives 1A–5 and 9 could substantially increase EC levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would result in somewhat lesser (but still substantial) increases in Suisun Marsh.

Based on their adverse effects on EC levels in Suisun Marsh as well as the adverse effects in the western and interior Delta, the BDCP alternatives would all contribute substantially to the adverse (significant) cumulative conditions for EC in the Delta. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased EC concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse (significant) cumulative condition. Implementation of CM2, CM3, and CM5–CM21 would not contribute substantially to this adverse (significant) cumulative condition.

Alternatives 4A, 2D, and 5A

Under Alternatives 4A, 2D, and 5A, the cumulative condition for EC is considered to be adverse in the Delta due primarily to periodically high levels of EC in the western Delta associated with sea water intrusion, and also in the south Delta. Implementation of facilities operations and maintenance under these action alternatives, along with Mitigation Measure WQ-11, would not be expected to contribute substantially to this adverse (significant) cumulative condition for EC, because no additional exceedance of Bay-Delta WQCP EC objectives would be expected, and substantial long-term degradation with respect to EC would be avoided. Additionally, unlike under the BDCP alternatives, implementation of tidal habitat restoration would not be expected contribute to increased EC levels, because the areal extent of the new restoration area would be a relatively small portion of the existing and planned Delta tidal habitat areas and, thus, not expected to measurably affect the Delta hydrodynamics. As such, implementation of Environmental Commitments is not expected to contribute to this adverse (significant) cumulative condition.

Mercury

Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, Upstream of the Delta and in the SWP/CVP Export Service Areas, which include a Delta mercury TMDL, methylmercury TMDL, and their implementation strategies (e.g., methylmercury control studies), increased restrictions on point-source discharges such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds. A key challenge surrounds the pool of mercury deposited in the sediments of the Delta which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Consequently, mercury levels in Delta waters are considered to be an adverse (significant) cumulative condition.

BDCP Alternatives

Facilities operations and maintenance (CM1) of Alternatives 1A–5 would not be expected to substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute substantially to the adverse (significant) cumulative mercury condition in the SWP/CVP Export Service Areas. Facilities operations and maintenance (CM1) of Alternatives 6A–9 would be expected to contribute substantially to the adverse (significant) cumulative condition for mercury in the Delta, since fish tissue concentrations are expected to increase measurably at several locations throughout the Delta. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), CM10 (freshwater marsh habitat), and CM2 (Yolo Bypass fisheries enhancements) could create conditions resulting in increased methylation of mercury within the Delta per unit time, increased biotic exposure to and uptake of methylmercury, and resulting increased mercury bioaccumulation in fish tissues. The methylation of mercury in these restored wetland habitats would contribute substantially to the cumulative condition for mercury in the Delta.

Alternatives 4A, 2D, and 5A

Facilities operations and maintenance of Alternatives 4A, 2D, and 5A would not be expected to substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute considerably to the adverse (significant) cumulative mercury condition in the SWP/CVP Export Service Areas. Mercury and methylmercury concentrations in water are not expected to change substantially under Alternatives 4A, 2D, and 5A. Fish tissue concentrations showed increases at some locations, but because the increases would be relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, the changes were considered to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment.

The amount of new habitat restoration to be implemented for the Environmental Commitments of Alternatives 4A, 2D, and 5A would be relatively small compared to the areal extent of the Delta, but implementation would be expected to contribute considerably to certain localized areas (i.e., near where the wetland restoration areas are planned) within the Delta through the potential for increased mercury methylation in these restored wetland habitats. Design of restoration sites would be guided by Environmental Commitment 12 of the action alternatives, which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although Environmental Commitment 12 would be implemented with the goal to reduce this potential effect, the uncertainties related to site-specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta could contribute substantially to the cumulative condition for mercury in the Delta.

As such, conveyance facility operation and maintenance is not expected to contribute to the adverse (significant) cumulative condition for mercury, but tidal habit restoration Environmental Commitments implemented under Alternatives 4A, 2D, and 5A could contribute to this adverse condition in localized areas.

Microcystis Blooms

The cumulative condition for *Microcystis* and, thus, microcystin concentrations is considered adverse in the Delta due to conditions being more favorable for their production. This includes future increased water temperatures associated with climate change and increased water residence times associated with climate change/sea level rise and habitat restoration that will enhance conditions for *Microcystis* blooms. *Microcystis* blooms can occur in the Delta during the June through September period of the year.

Climate change is expected to cause an increase in average Delta water temperatures during the summer and early fall months. Increased water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom in the Delta, and thus earlier occurrences of *Microcystis* blooms, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Nevertheless, it should be noted that projected Delta water temperature increases would be due entirely to climate change, and not due to the implementation of the action alternatives. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under the action alternatives, relative to the No Action Alternative.

An increase in residence time throughout the Delta is also expected due to climate change and sea level rise, although this change is believed to be fairly small in most areas of the Delta. Restoration areas, implemented either as part of the conservation measures of the BDCP alternatives, or separate actions under Alternatives 4A, 2D, and 5A, could also contribute to increased residence times.

BDCP Alternatives

The BDCP alternatives, including the implementation of habitat restoration under CM2 and CM4, would increase water residence times in the Delta during the summer period, relative to Existing Conditions and the No Action Alternative. Longer residence times in portions of the Delta may potentially increase the frequency, magnitude, and geographic extent of *Microcystis* blooms in Delta waters, relative to Existing Conditions and the No Action Alternative. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under the BDCP alternatives. However, the expected residence time changes under the BDCP alternatives, compared to Existing Conditions and the No Action Alternative, are in a direction and of magnitude that could lead to an increase in Delta *Microcystis* blooms.

Water diverted from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms as discussed above. Therefore, relative to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the North Delta under the BDCP alternatives serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether the BDCP alternatives will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Implementation of the BDCP alternatives (including CM2 and CM4) would contribute substantially to the adverse (significant) cumulative condition for *Microcystis* through their effects on residence time. Conversely, because projected Delta water temperature increases are due entirely to climate change, and are not due to the implementation of BDCP alternatives, implementation of the BDCP alternatives would not contribute substantially to the adverse (significant) cumulative condition for *Microcystis* via changes to Delta water temperature.

Alternatives 4A, 2D, and 5A

Change in flow paths of water through the Delta would occur under Alternatives 4A, 2D, and 5A, which could result in localized increases in residence time in various Delta sub-regions, and decreases in residence time in other areas. Implementation of the small amount of habitat restoration within the Delta, associated with the alternatives' Environmental Commitments, also could affect residence times at the affected areas. While there is uncertainty regarding the degree to which the alternatives would affect water residence times in the Delta, it is anticipated that the combined effects of restoration (to be implemented separate from the alternatives, e.g., EcoRestore), sea level rise and climate change will drive the residence time changes and that the alternatives and other cumulative projects would not contribute considerably to the adverse *Microcystis* and microcystins condition in the Delta, in particular because the amount of habitat restoration by the alternatives to be implemented would be so limited in area and location as it would not be able to affect residence times Delta-wide.

As described for the BDCP alternatives, the water flowing through the Delta that would reach the south Delta intakes is expected to be influenced by the increased frequency, magnitude, and geographic extent of *Microcystis* blooms associated with restoration (to be implemented separate from the alternatives, e.g., EcoRestore), sea level rise, and climate change. Water diverted from the Sacramento River in the north Delta that would be conveyed to the south Delta intakes is expected to be unaffected by *Microcystis* and microcystins. Therefore, the addition of Sacramento River water from the north Delta under Alternatives 4A, 2D, and 5A at the south Delta intakes would serve to dilute *Microcystis* and microcystins-containing water diverted from the south Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the south Delta is unknown, it cannot be determined whether levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants will be higher or lower, relative to Existing Conditions. However, because the Sacramento River water contributed to the south Delta intakes will likely be unaffected by *Microcystis* and microcystins, the alternatives would not contribute considerably to any future adverse *Microcystis* and microcystins condition in the SWP/CVP Export Service Areas.

Organic Carbon

Delta water quality conditions for DOC are anticipated to be adverse under the cumulative condition.

BDCP Alternatives

Facilities operations and maintenance (CM1) for Alternatives 1A–5 would not contribute considerably to the adverse (significant) cumulative condition for DOC within Delta waters based on modeling results showing little effect of these alternatives on long-term average concentrations. Conversely, Alternatives 6A–9 would result in increased DOC levels at Franks Tract, Rock Slough and Contra Costa PP No. 1. Under these alternatives, long-term average DOC concentration could increase by up to 46%, relative to Existing Conditions. Thus, the DOC contributions from alternatives 6A–9 at Franks Tract, Rock Slough and Contra Costa PP No. 1 (i.e., interior Delta locations) are determined to contribute considerably to the adverse (significant) cumulative condition for DOC in the Delta. However, overall, modeling results for the south Delta pumps and thus the SWP/CVP export service area predict a long-term improvement in export service area water quality, primarily through a reduction in exports of water exceeding 4 mg/L. This is particularly true for Alternatives 6A–9 where notable improvements to DOC levels at the south Delta pumps would occur. Hence, facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute substantially to adverse (significant) cumulative conditions in the interior Delta, but would improve cumulative DOC conditions at the south Delta pumps and thus in the SWP/CVP Export Service Areas.

In addition, implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) would create substantial new localized sources of DOC to Delta waters, and in some circumstances would substitute for existing sources related to replaced agriculture. In addition, CM2 would create greater localized source loading of DOC to Delta waters, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to Existing Conditions. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water supplies. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4, CM5, and CM10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect the MUN beneficial use at various interior Delta locations. Hence, implementation of CM2–CM21 would contribute substantially to the adverse (significant) cumulative condition for DOC.

Alternatives 4A, 2D, and 5A

Similar to Alternatives 1A–5, facilities operations and maintenance for Alternatives 4A, 2D, and 5A would not contribute considerably to the adverse (significant) cumulative condition for DOC within Delta waters based on modeling results showing little effect of these alternatives on long-term average concentrations. However, there would not be expected to be substantial contributions of

DOC from habitat restoration areas under Alternatives 4A, 2D, and 5A, because the area to be converted for new habitat would be small compared to areal extent of the Delta and existing habitat areas and loading sources. As such, facilities operations and maintenance and Environmental Commitments implemented under Alternatives 4A, 2D, and 5A would be minimal and are not expected to considerably contribute to this adverse condition.

Pesticides and Herbicides

Pesticide and herbicide use within and upstream of the Delta are changing continuously. Historically, when society has substituted one class of pesticide for another without a corresponding change in patterns of use (i.e., substitution of organochlorines with organophosphates), incidence of non-target toxicity or environmental harm has changed and perhaps been lessened, but has remained nevertheless. While factors such as TMDLs and future development of more target specific and less toxic pesticides will ultimately influence the future cumulative condition for pesticides, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. As such it is conservatively assumed that the cumulative condition will be adverse with respect to pesticides and herbicides in the Delta. The greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all action alternatives would be expected to result in the cumulative condition for pesticides and herbicides in the SWP/CVP Export Service Areas to not be adverse.

BDCP Alternatives

Alternatives 1A–5 are not expected to contribute considerably to the adverse (significant) cumulative condition due to facilities operations and maintenance (CM1). However, implementation of CM1 under Alternatives 6A–9 would result in long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 (interior Delta) increasing considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase at these locations. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing Clean Water Act Section 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. In addition, implementation of CM13 (nonnative aquatic vegetation control) under the BDCP alternatives would be expected to contribute substantially to the adverse (significant) cumulative condition for pesticides and herbicides in the Delta.

Alternatives 4A, 2D, and 5A

Alternatives 4A, 2D, and 5A are not expected to contribute considerably to the adverse (significant) cumulative condition due to facilities operations and maintenance, because the changes in the source water fractions of Sacramento River, San Joaquin River, and Delta agriculture water due to these alternatives would not be expected to be of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

Selenium

The lower San Joaquin River and the western Delta are listed as impaired in accordance with Section 303(d) of the Clean Water Act for exceeding selenium water quality objectives or bioaccumulation in biota. The San Joaquin River impairment is listed as extending from the Mud Slough confluence to the Airport Way Bridge near Vernalis, a reach distance of about 43 river miles. Selenium occurs naturally throughout the lower San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland Watershed. Subsurface agricultural drainage discharges from this area are the major source of selenium to the San Joaquin River and Delta. Load allocations for agricultural subsurface drainage discharges from the Grassland Drainage Area have been developed through completion of the lower San Joaquin River selenium TMDL and the Grassland Bypass Project. The Grassland Bypass Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands. The Grassland Area Farmers have been successful in meeting TMDL wasteload allocations and continue to utilize and expand the San Joaquin River Water Quality Improvement Project. Moreover, the Grassland Area Farmers continue to work closely with the Central Valley Water Board and U.S. Bureau of Reclamation to further develop and improve their drainage solutions for the Grassland Drainage Area. Despite these improvements in reducing selenium loading to the San Joaquin River and Delta, it is anticipated that the cumulative condition for selenium in the lower San Joaquin River and Delta will remain adverse.

While there have been improvements to selenium concentrations in San Francisco Bay, due in part to the petroleum refineries implementing controls that have decreased selenium in their discharges, the bay is currently CWA Section 303(d) listed as impaired for elevated selenium. TMDLs that will be developed to address the impairment would be expected to contribute to some reduction in selenium in the bay, including the North Bay, which is partially influenced by Delta outflow. Thus, it is anticipated that the future cumulative condition would be no worse, and possibly better than, existing conditions, but will remain adverse.

BDCP Alternatives

Facilities operations and maintenance (CM1) of Alternatives 1A–5 would not be expected to substantially alter the cumulative condition for selenium and selenium impairment in the Delta. Modeled selenium concentrations in sturgeon in the western Delta, in the San Joaquin River at Antioch and the Sacramento River at Mallard Island would increase under Alternatives 6A–9 by 17–42%, which may represent a measurable increase in the environment. These increases would contribute to low toxicity benchmarks being exceeded on average, in all years, and to high toxicity benchmarks being approached or exceeded during drought years. These increases would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial uses to be made discernibly worse. These potentially measurable increases would contribute substantially to the adverse (significant) cumulative condition for selenium in the Delta. However, the greater Sacramento River flow fraction at the south Delta pumps under all BDCP alternatives would be expected to result in reduced selenium concentrations in the SWP/CVP Export Service Areas and thus would not contribute to the adverse (significant) cumulative condition. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create conditions resulting in increased flow residence time at the restored Delta locations, which could increase biotic exposure to and uptake of selenium, potentially resulting in increased selenium bioaccumulation in fish tissues. The potential for increased biotic exposure in and near these restored wetland habitats would contribute substantially to the adverse (significant) cumulative condition for selenium in the Delta. However, *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium.

Alternatives 4A, 2D, and 5A

Facilities operations and maintenance of Alternatives 4A, 2D, and 5A would not be expected to substantially alter the cumulative condition for selenium and selenium impairment in the Delta. Modeling estimates indicate these alternatives would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, these alternatives would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium. The greater Sacramento River flow fraction at the south Delta pumps under Alternatives 4A, 2D, and 5A would result in reduced selenium concentrations in the SWP/CVP Export Service Areas and thus would not contribute to the adverse (significant) cumulative condition.

While the implementation of Environmental Commitment 4: Tidal Natural Communities Restoration would create shallow backwater areas that could result in local increased water residence times, the extent of these areas would be minimal relative to the area of the Delta, and environmental changes associated with their development are unlikely to be of magnitude that would measurably change selenium concentrations in water or biota, relative to Existing Conditions. Further, although water residence times associated with restoration could increase, they are not expected to increase without bound, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed water system. Further, proposed avoidance and minimization measures (AMMs) would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See BDCP Appendix 3.C, *Avoidance and Minimization Measures*, for additional detail on AMM27. Because selenium concentrations are not expected to build up in these areas and because *AMM27 Selenium Managemen*t, which affords for site-specific measures to reduce effects, would be available to reduce effects associated with selenium, the restored habitats are not expected to contribute considerably to the adverse (significant) cumulative condition.

Facilities operations and maintenance of Alternatives 4A, 2D, and 5A would not be expected to substantially alter the cumulative condition for the selenium impairment in the Delta or contribute considerably to the cumulative selenium condition in North Bay. Selenium concentrations in water in the Delta are not expected to change substantially under Alternatives 4A, 2D, and 5A, and thus these alternatives would not be expected to contribute considerable additional loading to the North Bay that would worsen the impairment.

NEPA Effects: The cumulative water quality conditions are considered to be adverse for bromide, chloride, electrical conductivity, mercury, *Microcystis* blooms, organic carbon, pesticides and herbicides, and selenium in areas of the Delta, and thus may adversely affect beneficial uses of the Delta such as domestic, agricultural, municipal and industrial water supply and recreation, aesthetic, and fish and wildlife resources.

BDCP Alternatives

The implementation of the BDCP alternatives would contribute substantially to these adverse (significant) cumulative water quality conditions. With respect to bromide, chloride, and electrical conductivity, implementation of the BDCP alternatives would improve water quality conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. Mitigation measures, conservation measures, and environmental commitments have been developed to mitigate the contributions of the BDCP alternatives to the adverse (significant) cumulative water quality conditions elsewhere in the Delta for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (CM12), *Microcystis* blooms (WQ-32a and WQ-32b), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (WQ-21 and WQ-22) and selenium (*AMM27 Selenium Management*).

Alternatives 4A, 2D, and 5A

The implementation of the water conveyance facilities operations and maintenance component of Alternatives 4A, 2D, and 5A, including Mitigation Measure WQ-11 proposed for EC, would not contribute considerably to adverse (significant) cumulative water quality conditions for these constituents. With respect to chloride and EC, implementation of Alternatives 4A, 2D, and 5A would improve water quality conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. The implementation of habitat restoration Environmental Commitments could contribute considerably to the adverse (significant) cumulative water quality condition for mercury. Environmental Commitment 12 would be implemented to minimize conditions that promote the production of methylmercury.

CEQA Conclusion: Separate conclusions are provided for the BDCP alternatives and Alternatives 4A, 2D, and 5A.

BDCP Alternatives

The cumulative Delta water quality conditions are anticipated to be significant for bromide, chloride, electrical conductivity, mercury, *Microcystis* blooms, organic carbon, pesticides and herbicides, and selenium.

The incremental effects of the BDCP alternatives would be cumulatively considerable with respect to significant cumulative bromide, chloride, *Microcystis*, and electrical conductivity conditions at various western and interior Delta locations. However, implementation of the BDCP alternatives would not contribute considerably, and would, in fact, improve conditions for these constituents (except *Microcystis*) at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. It cannot be determined whether the BDCP alternatives will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions.

Implementation of WQ-5 may reduce impacts on bromide relative to municipal and industrial beneficial uses in Barker Slough, but it is not known whether actions to reduce this impact under the mitigation measures are feasible. Implementation of Mitigation Measures WQ-7a, WQ-7b, WQ-11a, and WQ-11b may reduce impacts on chloride relative to municipal and industrial beneficial uses and EC relative to agricultural beneficial uses in the western Delta, but it is not known whether actions to reduce this impact under the mitigation measures are feasible. Implementation of Mitigation measure WQ-11c may reduce potential impacts of EC on fish and wildlife beneficial uses in the interior Delta, but it is not known whether actions to reduce this impact under the mitigation measure are feasible. Thus, for these impacts, the contribution to the adverse (significant) cumulative condition is expected to remain significant. Implementation of Mitigation Measures WQ-7d and WQ-11d is expected to reduce the contribution of impacts on chloride and EC water quality degradation in Suisun Marsh to a less-than-significant level. Implementation of WQ-32 may reduce potential impacts on *Microcystis* in the Delta, but it is not known whether actions to reduce this impact under the mitigation measure are feasible; thus, the contribution to the adverse (significant) cumulative condition is expected to remain significant.

Regarding mercury and selenium, facilities operations and maintenance (CM1) would not be expected to contribute considerably to the significant cumulative mercury and selenium conditions in the Delta for Alternatives 1A–5, but would be expected to contribute to these conditions for Alternatives 6A–9. Implementation of CM4, CM5, and CM10 would be expected to contribute considerably to certain localized areas (i.e., near where the wetland restoration areas are planned) within the Delta through the potential for increased mercury methylation and selenium bioaccumulation in these restored wetland habitats. Although CM12 is designed to reduce these effects for mercury, it is not known if these actions would be feasible and could effectively reduce the incremental contribution to the adverse (significant) cumulative condition to a less-than-significant level. However, with implementation of *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, the incremental effects of these CMs on selenium would not be expected to be cumulatively considerable. Likewise, CM2 would create greater localized source loading of methylmercury to Delta waters, to the degree that the Yolo Bypass would be inundated more frequently and/or to a greater geographic extent under the alternatives, relative to Existing Conditiosn. Conversely, CM2 is not expected to contribute considerably to future Delta selenium levels and thus would not be expected to affect future bioaccumulation of selenium in Delta fish tissues.

For organic carbon, implementation of facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute considerably to the significant cumulative organic carbon condition in the Delta, but Alternatives 1A–C, 2A–C, 3, 4 and 5 would not contribute considerably to this cumulative condition. Conservation Measures 4, 5, and 10, through the ability of these new wetlands to load additional organic carbon to Delta waters, would contribute considerably to the significant adverse (significant) cumulative organic carbon condition in the Delta. In addition, CM2 would create greater localized source loading of DOC to Delta waters for all BDCP alternatives, to the degree that the Yolo Bypass would be inundated more frequently and/or to a greater geographic extent under the alternatives, relative to Existing Conditions. Implementation of Mitigation Measure WQ-17 and WQ-18 may reduce these contributions, but it is unknown whether these actions would be feasible and would effectively reduce the incremental contribution to the adverse (significant) cumulative condition to a less-than-significant level. These cumulative effects are not expected to extend to the south Delta pumps or the SWP/CVP Export Service Areas.

Implementation of facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute considerably to the adverse (significant) cumulative pesticide and herbicide condition in the Delta, but Alternatives 1A–5 would not contribute considerably to this significant cumulative condition. Also, implementation of CM13 (nonnative aquatic vegetation control) is the only conservation measure identified that would contribute considerably to the cumulative pesticide and herbicide condition in the Delta. However, with implementation of Mitigation Measure WQ-22, the contribution to the cumulative condition of CM13 is expected to be less than significant. The cumulative effects for pesticides and herbicides are not expected to extend to the SWP/CVP Export Service Areas due to the increases in Sacramento River source fraction at Banks and Jones pumping plants under all BDCP alternatives and its generally lower levels of pesticides relative to the San Joaquin River source water.

Alternatives 4A, 2D, and 5A

The incremental effects of the water conveyance facilities operations and maintenance component of Alternatives 4A, 2D, and 5A, including Mitigation Measure WQ-11 proposed for EC, would not be expected to be cumulatively considerable for chloride and EC conditions in the Delta. Implementation of Alternatives 4A, 2D, and 5A would, in fact, improve conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas.

Facilities operations and maintenance under Alternatives 4A, 2D, and 5A would not be expected to contribute considerably to the significant cumulative *Microcystis* condition in the Delta through increased residence times in the Delta during the summer period. Similarly, Environmental Commitments are not expected to contribute to this significant cumulative condition, because the area of restoration would be so small as to have no net effect on through-Delta residence time.

Facilities operations and maintenance would not be expected to contribute considerably to the significant cumulative mercury and selenium conditions in the Delta. Implementation of habitat restoration Environmental Commitments could contribute considerably to the significant cumulative mercury condition at certain localized areas within the Delta (i.e., near where the wetland restoration areas are planned) through the potential for increased mercury methylation in these restored wetland habitats. Although Environmental Commitment 12 is designed to reduce these effects for mercury, it is not known if these actions would be feasible and could effectively reduce the incremental contribution to the adverse (significant) cumulative condition to a less-than-significant level. With implementation of *AMM27 Selenium Management*, which affords for site-specific measures to reduce effects, the incremental effects of habitat restoration on selenium would not be expected to be cumulatively considerable.

Implementation of facilities operations and maintenance for Alternatives 4A, 2D, and 5A would not contribute considerably to the significant cumulative organic carbon condition in the Delta. Habitat restoration Environmental Commitments would potentially load additional organic carbon to Delta waters, but contributions are not expected to be cumulatively considerable, because the land area proposed for restoration would be relatively small compared to existing land area and sources of DOC as to not have an effect on DOC concentrations.

Implementation of facilities operations and maintenance for Alternatives 4A, 2D, and 5A would not contribute considerably to the adverse (significant) cumulative pesticide and herbicide condition in the Delta, because the changes in the source water fractions of Sacramento River, San Joaquin River, and Delta agriculture water, due to the alternatives, would not be expected to be of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Further, the Environmental Commitments would not involve actions that would contribute to additional pesticide loading, and thus would not contribute considerably to the significant cumulative pesticide condition in the Delta.

Mitigation Measures

BDCP Alternatives

The following conservation measure mitigation measures, and environmental commitment have been developed to mitigate the contributions of the BDCP alternatives to the adverse (significant) cumulative water quality conditions described above for bromide (Mitigation Measure WQ-5), chloride (Mitigation Measure WQ-7), electrical conductivity (Mitigation Measures WQ-11a, 11b, 11c, and 11d), mercury (CM12), organic carbon (Mitigation Measures WQ-17 and WQ-18), pesticides and herbicides (Mitigation Measure WQ-22) and selenium (*AMM27 Selenium Management*). As noted for the BDCP alternatives in Section 8.3.3, it is expected that the impacts on these constituents would remain significant and unavoidable with mitigation.

Alternatives 4A, 2D, and 5A

The following mitigation measures and Environmental Commitment have been developed to mitigate the contributions of Alternatives 4A, 2D, and 5A to the adverse (significant) cumulative water quality conditions described above for electrical conductivity (Mitigation Measures WQ-11e and 11f) and mercury (Environmental Commitment 12). As noted for these alternatives in Section 8.3.4, it is expected that the impacts on mercury would remain significant and unavoidable with mitigation; however, impacts on EC would be reduced to a less-than-significant level.

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