

2009 PLAN FOR WATER QUALITY MANAGEMENT ACTIONS FOR COPCO AND IRON GATE RESERVOIRS (VERSION: APRIL 30, 2009)

INTRODUCTION

This *2009 Plan for Water Quality Management Actions for Copco and Iron Gate Reservoirs* (2009 Plan) describes several actions PacifiCorp is implementing during 2009 for improving water quality in Copco and Iron Gate reservoirs. This 2009 Plan specifically describes the purposes and objectives of the 2009 actions, the tasks and work activities associated with each of the actions, and the anticipated schedule for completing the actions.

As a result of large upstream organic and nutrient loads, Copco and Iron Gate reservoirs experience high primary production, including cyanobacteria (blue-green algae) blooms, primarily during the summer. The intent of this 2009 Plan is to implement actions that will improve water quality conditions related to the primary production, respiration, and decay processes within the reservoirs (and attendant effects on summertime algae blooms, dissolved oxygen and pH conditions). The implemented actions, when combined with implementation of potential actions by others to control and reduce nutrient loads upstream of the Project, are expected to provide substantial and sustained water quality improvements in and below Copco and Iron Gate reservoirs.

Relationship of the 2009 Plan to Agreement in Principle Interim Measures

On November 13, 2008, the United States, the States of California and Oregon, and PacifiCorp executed an Agreement in Principle (AIP) describing the framework for an approach to possible dam removal on the Klamath River. Interim Measure 11 of the AIP, titled *Nutrient Reduction Measures*, provides for PacifiCorp's implementation under a final settlement agreement of nutrient reduction measures to improve water quality within Copco and Iron Gate reservoirs, and to address implementation of the *Water Quality Control Plan for the North Coast Region* (Basin Plan), including Total Maximum Daily Loads (TMDLs). Under the AIP, PacifiCorp has agreed to begin, in advance of a final agreement, implementation of a water quality monitoring and planning program in support of Interim Measure 11.

Interim Measure 10 of the AIP, titled *Iron Gate Turbine Venting*, provides that PacifiCorp will test turbine venting at Iron Gate dam and, if determined to be a successful and viable tool for improving dissolved oxygen (DO) concentrations downstream of Iron Gate dam, shall implement turbine venting on an ongoing basis. This 2009 Plan includes a description of actions related to turbine venting at Iron Gate being implemented in 2009.

The AIP includes three other water quality-related interim measures. Interim Measure 5, titled *J.C. Boyle Reservoir Water Quality*, provides that, upon signing a final agreement, PacifiCorp will study measures to improve water quality in J.C. Boyle reservoir, such as aeration or mixing to improve DO within the reservoir, or other measures such as wetlands development. Implementation of feasible enhancement measures would begin following the Federal determination described in the AIP. Interim Measure 12, titled *Water Quality Monitoring*,

provides that PacifiCorp will fund a water quality monitoring program, including on-going monitoring of cyanobacteria (blue-green algae) and associated toxin. Interim Measure 22, titled *Water Quality Technical Conference*, provides that PacifiCorp will fund a basin-wide technical conference on water quality. While still under development, the intent of this measure is to improve understanding of basin-wide water quality impairment and explore solutions to improve water quality through technical, regulatory, or other means. Interim Measures 5, 12, and 22 are, or will be, addressed in other separate plans, and are not included as specific actions in this 2009 Plan.

Relationship of the 2009 Plan to Previous Reservoir Management Plans

PacifiCorp previously prepared and implemented Reservoir Management Plans (RMPs) in 2007 and 2008 to evaluate the effectiveness and feasibility of various technologies and measures to more effectively control water quality conditions in Copco and Iron Gate reservoirs. The technologies and measures assessed in the RMPs focused on improving water quality conditions in the reservoirs that result from significant loads of organic and nutrient matter originating from upstream of the Project (PacifiCorp 2007, PacifiCorp 2008). In effect, this 2009 Plan serves as a revised RMP similar to those developed in 2007 and 2008. As with the previous RMPs, the 2009 Plan continues the evaluation and implementation of various technologies and measures to improve water quality conditions in Copco and Iron Gate reservoirs, particularly those conditions that result from significant loads of organic and nutrient matter from upstream sources.

These 2009 activities supplement previous studies regarding reservoir management activities, including wetland treatment, in-reservoir oxygenation, reoperation (selective withdrawal and storage management), surface mixing, limnological investigation, and other studies. The efficacy of these activities and actions has been variable, wherein beneficial effects range from substantial to minimal. Studies to date have not examined the synergistic effect of multiple prescriptions in addressing water quality conditions in the reservoirs. As such, PacifiCorp believes that retaining the findings from all these actions is important in considering future reservoir management approaches.

WATERSHED OR RESERVOIR INFLOW MANAGEMENT ACTIVITIES DURING 2009

Watershed and inflow water quality management is unaffected by and beyond the control of PacifiCorp's Project operations. However, given that water quality conditions in Copco and Iron Gate reservoirs are largely driven by the large nutrient and organic loads from upstream sources (particularly Upper Klamath Lake), improvements in watershed and upstream water quality will be essential to appreciable sustained water quality improvements in Copco and Iron Gate reservoirs and riverine reaches downstream of Upper Klamath Lake.

This section describes activities for watershed and inflow water quality management activities during 2009, including the justification and objective for the activity, and the specific tasks and schedules that PacifiCorp is implementing to conduct the activities.

Concepts and Approaches for Basin-Wide Water Quality Credit Trading

Purpose and Objective

The *Water Quality Restoration Plan for the Klamath River Basin in California: Draft Scoping for TMDL Implementation* (Regional Water Board 2009a) considers a variety of implementation options to address water quality impairments in the Klamath River, including the opportunity for “water quality credit trading” in the Klamath Basin. Water quality credit trading is based on the concept that sources of pollutants in a watershed can face very different efficiencies and costs to control the same pollutant. Trading programs allow facilities facing lower efficiencies and higher pollutant reduction costs to achieve water quality improvements by purchasing environmentally equivalent (or superior) pollutant reductions from another source, thus achieving the same or greater overall water quality improvement with greater efficiency.

Water quality credit trading in the Klamath Basin could provide downstream users such as PacifiCorp an efficient option for helping to reduce nutrient loads from upstream to offset water quality impairments in the Klamath River.

Tasks and Work Elements

The tasks and work elements associated with this activity in 2009 will include the following:

- Identify water quality constituents amendable to trading
- Identify potential traders and other stakeholders
- Explore potential constituent control approaches, credit calculation methodology, and range of unit credit costs

The above tasks are intended to define the framework for a potential program and allow all parties to assess elements of water quality credit trading in the Klamath Basin. Should program activities be developed further, future tasks and work elements would include:

- Define Klamath Basin specific constituent control approaches, credit calculation methodology, and range of unit credit costs
- Identify trading program barriers and develop solutions
- Plan for stakeholder information and input
- Develop candidate market structures
- Describe preferred program structure
- Prepare trading program implementation plan and cost estimates

PacifiCorp has engaged Regional Water Board staff on scoping discussions and prepared two preliminary deliverables for this action, including (1) an outline of a technical study and program development plan, and (2) an outline of a stakeholder information and participation plan. These documents are intended to assist the Regional Water Board and Oregon

Department of Environmental Quality (DEQ) in drafting appropriate language for upcoming TMDL documents.

Schedule

Outlines for: (1) a technical study and program development plan; and (2) a stakeholder information and participation plan	June 2009
Program Development and Technical Study Plan	September 2009
Develop Stakeholder Information and Participation Plan	September 2009
Implement Stakeholder Information and Participation Plan	December 2009
Technical Studies: Methodology and Feasibility	March 2010

Constructed Treatment Wetland Technical Meetings

Purpose and Objective

Constructed treatment wetlands have been identified as potentially viable means of improving water quality conditions in the upper Klamath River (Rabe et al. 2008, Lyon et al. 2008, Deas and Vaughn 2006). Target water quality improvements include reduced total suspended solids and organic matter (biochemical oxygen demand). These studies, as well as related work around Upper Klamath Lake (e.g., Aldous et al. 2007, Duff et al. 2009, Carpenter et al. 2009), suggest that nutrient removal through treatment wetlands is modest, but may provide additional benefit at the overall watershed level.

The purpose of this task is to conduct a series of technical meetings with regulatory agencies and specific stakeholders to discuss lessons learned from feasibility studies of constructed treatment wetlands in the Project area and at Keno Reservoir. These meetings also are intended to clarify how wetlands treatment may be relevant to PacifiCorp's obligations under a final settlement agreement or in other contexts.

Tasks and Work Elements

The tasks and work elements associated with this activity in 2009 will include the following:

- Identify elements of constructed treatment wetlands that relate to PacifiCorp's obligations under a final settlement agreement or in other contexts.
- Meet with identified agencies and entities to share information on constructed wetlands treatment, PacifiCorp's activities in wetlands treatment studies, and the role PacifiCorp may potentially play in constructed wetland treatment activities related to water quality improvement.

- Produce a technical memorandum summarizing meetings with agencies and entities and associated planning activities and any identified actions. Include time frames for any actions as appropriate. There may be cross-over with other items identified in this plan.

Schedule

Identify wetland elements associated with PacifiCorp's obligations under a final settlement agreement or in other contexts	August 1, 2009
Schedule and attend meetings with agencies and entities	August-November 2009
Technical memorandum	January 31, 2010

Constructed Treatment Wetland Pilot Program

Purpose and Objective

PacifiCorp is considering a constructed treatment wetland pilot project to improve understanding and assist in development of large-scale constructed treatment wetlands. An opportunity may exist to work cooperatively with the U.S. Bureau of Reclamation (Reclamation) to initiate a pre-designed pilot wetland adjacent to Keno Reservoir near Klamath Falls. Reclamation has funded the construction portion of a pilot project (Proposal No. 08SF200023: \$484,707), and there is the possibility that PacifiCorp, under AIP Interim Measure 11 (*Nutrient Reduction Measures*), could cooperatively support the pilot project through funding a property purchase or other means.

Tasks and Work Elements

The tasks and work elements associated with this activity in 2009 will include the following:

- Prepare a package of information on potential partnership with Reclamation on a constructed treatment wetland pilot project. The package would include information on project roles and responsibilities (i.e., including for Reclamation, PacifiCorp, and consultants Rabe Consulting, Geoengineers, and Watercourse Engineering), work activities, and likely planning for pilot project construction in 2010.
- Identify potential land acquisition options and transfer to third party options. Assess costs of potential land acquisition options and transfer. This information would guide PacifiCorp decision-making regarding PacifiCorp's role in the project.
- Prepare a summary identifying how PacifiCorp's participation in the constructed treatment wetland pilot project would fit into PacifiCorp's AIP responsibilities.

- Conduct follow-up activities as appropriate that are indentified in the planning steps as described above.

Schedule

Initial Package	June 2009
Conference Call	June-July 2009
Summary	July-August 2009
Follow-up	July or after, 2009

IN-RESERVOIR WATER QUALITY MANAGEMENT ACTIVITIES DURING 2009

This section describes activities for water quality management in Copco and Iron Gate reservoirs during 2009, including the justification and objective for the activity, and the specific tasks and schedules that PacifiCorp is implementing to conduct the activities.

Curtain Installation in Iron Gate Reservoir in the Vicinity of the Dam Intake

Purpose and Objective

This activity involves the continued evaluation of a floating barrier curtain that was installed in 2008 along the log boom in Iron Gate reservoir in the vicinity of the dam intake. The curtain is a Layfield Type 1 Turbidity Curtain synthetic fabric material¹ suspended to a depth of 10 feet that extends across the entire width of the reservoir (approximately 1100 feet) at the current log boom location, which is about 1800 feet upstream of the dam.

The primary objective of the barrier curtain is to enhance water quality in the vicinity of the dam intake by excluding or reducing the potential entrainment of biomass from blooms of cyanobacteria (blue-green algae) such as *Microcystis* and potential associated algal toxins (i.e., microcystin). The curtain is intended to provide a barrier to drift and accumulation near the dam (and power intakes) of algae biomass in the reservoir's photic zone, especially buoyant algae bloom material at the water surface.

Tasks and Work Elements

The tasks and work elements associated with continued evaluation of a barrier curtain in Iron Gate reservoir in the vicinity of the dam intake will include the following:

- Water quality will be monitored within and outside of curtained areas in the lower part of the Iron Gate reservoir near the dam intake and downstream of the powerhouse discharge to assess the effect of the curtain on water quality. The details of this monitoring (e.g., parameters to be measured, frequency of sampling, etc.) will be described in a water quality monitoring sampling plan (PacifiCorp *in preparation*).

¹ Specifications for the Layfield Type 1 Turbidity Curtain synthetic fabric are available at <http://www.layfieldgroup.com/splash.cfm>.

- Movement of water currents in the vicinity of the curtain will be measured using an Acoustic Doppler Current Profiler (ADCP). The ADCP data will be used to characterize vertical velocity profiles adjacent to and around the curtain. The data will be used in concert with modeling (described below) to assess the effectiveness of the curtain in confining movement of algae biomass or bloom material, and to determine the need for potential adjustments to the curtain to enhance effectiveness (e.g., deepening the curtain).
- Modeling will be conducted using the CE-QUAL-W2 water quality model of the reservoir developed by Watercourse Engineering (the model that has been modified by the Regional Water Board and EPA for development of the TMDL) to assess curtain effects on water quality under varying conditions. These conditions will include potential variations in water column temperature gradients (and hence water column density and stability), and potential variations in buoyancy, settling, or vertical migration rates of cyanobacteria species, particularly *Microcystis*. The modeling information will be used along with monitoring data to determine the need for potential adjustments to the curtain to enhance effectiveness.
- A technical memorandum will be prepared to present findings and recommendations. The conclusions and recommendations of the memorandum will serve as a guide for potential future adjustments to and continued use of this technique.

Schedule

Monitoring of curtain	May-October 2009
ADCP profiling and CE-QUAL modeling	July-September 2009
Technical memorandum	December 2009

Turbine Venting System for Dissolved Oxygen Enhancement at Iron Gate

Purpose and Objective

Daily mean DO conditions are at or near saturation throughout the Klamath River downstream of Iron Gate dam due to the many rapids and riffles in the river that provide mechanical reaeration (PacifiCorp 2008). An exception is the reach immediately below Iron Gate dam during late summer and fall periods, where the relatively deep reservoir intake withdraws water from Iron Gate reservoir that can result in discharges from the powerhouse of water with low DO concentration.

During summer 2008, PacifiCorp completed turbine venting tests at the Iron Gate powerhouse that showed a positive improvement in DO concentration measured in the Klamath River below Iron Gate powerhouse. DO increased by up to about 2 mg/L and 20 percent saturation as a result of full air admission through the existing turbine vent valve design at turbine flows of 1,000 cfs to 1,500 cfs. In addition, measurements indicated that turbine venting produces a negligible increase in Total Dissolved Gas (TDG) in turbine discharges to the river.

During 2009, PacifiCorp plans to install a forced-air blower on an existing, but previously closed, air introduction manifold to increase air entrainment in the turbine draft tube. The installation of the blower is expected to increase air entrainment into the turbine draft tube and further enhance DO concentration below the Iron Gate powerhouse. This new system will be installed and tested in 2009 and turbine venting will be initiated when DO levels are observed to fall below 87 percent saturation in the Klamath River immediately below Iron Gate powerhouse. PacifiCorp will conduct additional testing and evaluation of this turbine venting system at Iron Gate by this year, and will include development of a Standard Operating Procedure (SOP) for this action. Implementing turbine venting at 87 percent saturation will ensure that available means to provide enhanced DO levels are in operation when the level approaches 85 percent, which is the proposed basin standard (Regional Water Board 2008).

Tasks and Work Elements

The tasks and work elements associated with testing and evaluation of the turbine venting system at Iron Gate will include the following:

- PacifiCorp will conduct further testing of turbine venting during 2009 using a manifold that could provide additional air flow to the turbine draft tube. This air admission manifold is currently capped off but will be opened during the Iron Gate powerhouse annual outage in May 2009. A forced-air blower will be installed on this manifold to increase the air entrainment into the turbine draft tube, which should increase DO below Iron Gate powerhouse.
- A continuous automated water quality datasonde was installed downstream of Iron Gate dam near the Iron Gate Hatchery bridge (at RM 189.8) in June 2008. DO in milligrams per liter (mg/L) and percent saturation (% saturation) will be monitored on an hourly basis before, during, and after turbine venting testing and operations. (Note: the datasonde is also equipped to measure water temperature, pH, specific conductance, and phycocyanin, a surrogate measure of blue-green algae.)
- PacifiCorp plans to implement turbine venting at Iron Gate dam in 2009 when DO levels are observed to fall below 87 percent saturation in the Klamath River immediately below Iron Gate powerhouse.
- After completion of 2009 operations, tests, and monitoring, PacifiCorp will develop a Standard Operating Procedure (SOP) for the turbine venting system in consultation with the National Marine Fisheries Service (NMFS)². PacifiCorp will submit a final turbine venting SOP to the Federal Energy Regulatory Commission (FERC) for its review and approval.

² On November 10, 2008, PacifiCorp submitted an Interim Conservation Plan (ICP) to the NMFS and the U.S. Fish and Wildlife Service identifying interim conservation actions that PacifiCorp proposes to commence implementing at the Project. PacifiCorp developed the ICP in consultation with the Services to address the Services' concerns about potential effects of Project operations on listed species that could occur during the interim period prior to reestablishment of fish passage in the Project area. The implementation of turbine venting, including the development of the SOP, is included in the ICP.

Schedule

Complete blower installation	July 2009
Turbine venting operations and testing	July-October 2009
Turbine venting monitoring	August-September 2009
Technical report	December 2009
Final Turbine Venting Plan/SOP	February 2010

High-Energy Circulator Testing in Copco Reservoir

Purpose and Objective

In 2007 and 2008, PacifiCorp conducted tests of solar-powered water circulators (i.e., SolarBee™) in Copco reservoir to assess the effectiveness of surface or epilimnetic circulation as a reservoir water quality enhancement measure. The intent of such circulation is to mix water and minimize quiescent conditions in surface layers of the reservoirs, such as in the euphotic zone or in coves or embayments, to control algae growth. The surface mixing and agitation caused by this circulation is expected to reduce cyanobacteria (blue-green algae) by reducing their light exposure (by mixing the algae out of the euphotic zone) or disrupting the generally quiescent conditions that may contribute to bloom formation.

Although the tests of solar-powered water circulators showed promise, results were inconsistent and inconclusive, and substantive effects on algae growth were not evident. During 2009, PacifiCorp plans evaluation of another type of circulator that is capable of moving or mixing more water (i.e., higher-energy circulator) than the solar-powered units. It is assumed that a higher-energy circulator would provide more complete (deeper) mixing and light-limited algae growth conditions in the reservoir. Further evaluation is needed to gain better reliability and effectiveness information prior to scaling up to more extensive implementation of circulators in Copco and Iron Gate reservoirs.

Tasks and Work Elements

The tasks and work elements associated with testing and evaluation of the higher-energy circulator in Copco reservoir will include the following:

- Information will be gathered on commercially-available higher-energy mixers/circulators for potential application in Copco reservoir. Emphasis will be placed on mixers/circulators that have a successful record of use in other lakes and reservoirs (e.g., ITT Flygt, KSB). The research literature on use and effectiveness of these higher-energy mixer/circulators will be reviewed and summarized. Manufacturers will be contacted for information and specifications on available mixers/circulators, and the required equipment and power to support them in field applications.

- Information will be gathered on sinking/rising rates of algae in the reservoirs, and mixing depth required to impose light limitation on algae growth. The research literature on sinking/rising rates of algae will be reviewed and summarized, with emphasis on *Microcystis*. Actual bench tests of sinking/rising rates of *Microcystis* may be conducted to supplement this information.
- Based on above information, PacifiCorp will consult with the Regional Water Board on a possible demonstration installation of a higher-energy circulator in a selected cove at Copco reservoir. The demonstration would occur during summer in either 2009 or 2010, depending on the outcome of planning activities described above and lead times required for equipment procurement and installation. The pilot test will be conducted to assess two objectives: (1) to assess operational consistency and reliability in field conditions, and (2) to assess water quality improvement in the “treated” cove area relative to other “untreated” areas, particularly in controlling accumulations of *Microcystis*. Water quality will be monitored before, during, and after deployment of the circulator, and will include in-situ sampling of water clarity (i.e., Secchi depth), vertical profiles (of temperature, dissolved oxygen, and pH), and epilimnetic chlorophyll a and phytoplankton composition. Monitoring will occur in the “treated” cove area and other “untreated” areas in Copco reservoir to test for the effectiveness of the circulator’s lateral mixing and circulation.
- The information developed from the above tasks and work elements will be compiled in a technical report. The conclusions and recommendations of the report will serve as a guide for potential future expanded deployment of circulators in Copco and Iron Gate reservoirs.

Schedule

Information gathering and modeling	June-July 2009
Planning of in-reservoir circulator tests	July-August 2009
Circulator deployment, testing, and monitoring	August-September 2009 or 2010
Technical report	January 2010 or 2011

Mechanical Removal of Algae Biomatter from Copco and Iron Gate Reservoirs

Purpose and Objective

Direct collection and removal (i.e., “harvesting”) of algae bloom material is not common in lakes and reservoirs as a technique for enhancing water quality. Typically direct harvesting cannot feasibly remove a large enough percentage of the algae biomatter to substantially improve water quality. Despite limitations, direct removal from biomass harvesting might offer an optional approach for reducing surface accumulations of algae from localized reservoir areas, such as those areas at or near picnic sites or boat launches. The algae biomatter removed from localized reservoir areas may not make a significant contribution to reducing reservoir eutrophication, but could improve the conditions for users of these areas. On this basis, PacifiCorp plans during 2009 to evaluate the use of an algae collection system in Copco and

Iron Gate reservoirs. PacifiCorp plans to retain the services of Simplexity to assist with this task during 2009.

Tasks and Work Elements

The tasks and work elements associated the evaluation of an algae collection system will include the following:

- Information will be gathered on optional collection techniques and potential uses of algae biomatter from Project reservoirs to help determine whether direct harvesting of algae from the Project reservoirs is a feasible management option. Information would emphasize how harvesting and removal of algae biomatter would be accomplished, and how collected algae biomatter would be disposed or otherwise potentially used. Applicable regulatory requirements associated with such collection, disposal, or uses will be identified.
- PacifiCorp, with assistance from Simplexity, will assess feasibility of alternative conceptual approaches for algae collection. The pros and cons of different approaches will be identified. If feasible, a preferred conceptual system will be recommended with approximate associated costs and timelines for possible construction and implementation. It is anticipated that the recommended algae collection system will take advantage of Simplexity's knowledge and experience in performing harvesting on Upper Klamath Lake using a custom-built harvest system. This system uses on-site vessels and equipment to gather algae biomatter, perform "pre-screening" and "primary separation" steps during which algae biomatter is filtered out of the water with fine mesh screens, and further concentrate the algae material into a paste-like consistency by removing more water using mechanical separators. A tanker truck can then be used to transport the paste-like material for disposal or other uses (to be identified).
- PacifiCorp in consultation with the Regional Water Board and with assistance from Simplexity, will develop a plan to design, construct, and install the recommended algae collection system (if determined feasible). The plan will include details on the design and installation of the algae collection system, operation and maintenance of the installed algae collection system, and transport and disposal of the collected algae material. Proper disposal protocols, practices, and sites will be determined, but could include land application in grassy swales specifically designed for algae removal on near-by PacifiCorp property.

Schedule

Information gathering on optional methods	June-July 2009
Assess feasibility and recommend preferred method	August-September 2009
Design and implementation plan	November 2009

Testing and Evaluation of Chemical Treatment for Localized Algae Control in Project Reservoirs

Purpose and Objective

In 2008, PacifiCorp retained Watercourse Engineering to initiate effectiveness testing of sodium carbonate peroxyhydrate (e.g., PAK™27) applications in Copco and Iron Gate reservoirs based on controlled bench tests using water taken from the reservoirs. Sodium carbonate peroxyhydrate is approved for use as an algaecide by the U.S. Environmental Protection Agency (EPA), and is also approved under NSF/ANSI Standard 60 (drinking water treatment chemicals). On February 27, 2006, the California Department of Pesticide Regulation (DPR) registered sodium carbonate peroxyhydrate for aquatic application as an algaecide used to control blue-green algae (see Water Quality Order No. 2004-0009-DWQ NPDES No. CAG990005 National Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States, as amended by adoption of State Water Resources Control Board [State Water Board] Resolution No. 2006-0039).

The bench tests conducted by Watercourse Engineering in 2008 indicated that sodium carbonate peroxyhydrate applications may be effective in reducing the growth of algae in water from the reservoirs. During 2009, PacifiCorp plans to continue effectiveness testing of sodium carbonate peroxyhydrate applications in Copco and Iron Gate reservoirs using larger-scale test enclosures, potentially adjacent to the reservoirs. This further testing will allow additional effectiveness and implementation information to be gathered, and will provide important details on potential full-scale applications to reservoir areas.

Tasks and Work Elements

The tasks and work elements associated with further effectiveness testing of sodium carbonate peroxyhydrate applications in the reservoirs will include the following:

- PacifiCorp and Watercourse Engineering will meet with the Regional Water Board to discuss the results of tests conducted in 2008, obtain input on planned further testing in 2009, and discuss probable regulatory requirements for potential full-scale applications in Copco and Iron Gate reservoirs if pursued in the future.
- Create field study plan for 2009, based on 2008 findings.
- Complete field study and document the results in a technical memorandum.
- The information developed from the above tasks and work elements will be compiled in a technical report. The conclusions and recommendations of the report will serve as a guide for potential future sodium carbonate peroxyhydrate applications in the reservoirs.

Schedule

Meeting and discussions with State Water Board	May-June 2009
Study Plan	June-July 2009

Field Study
Technical report

July-August 2009
February 2010

REFERENCES

- Aldous, A.R., C. B. Craft, C. J. Stevens, M. J. Berry, and L. B. Bach. 2007. "Soil phosphorus release from a restoration wetland, Upper Klamath Lake, Oregon." *Wetlands* 27(4):1025-1035.
- Carpenter, K.D., Snyder, D.T., Duff, J.H., Triska, F.J., Lee, K.K., Avanzino, R.J., and Sobieszczyk, Steven. 2009. Hydrologic and water-quality conditions during restoration of the Wood River Wetland, upper Klamath River basin, Oregon, 2003–05. U.S. Geological Survey Scientific Investigations Report 2009-5004, 66 p.
- Deas, M.L., and J. Vaughn. 2006. Characterization of Organic Matter Fate and Transport in the Klamath River below Link Dam to Assess Treatment/Reduction Potential. Prepared for U.S. Bureau of Reclamation, Klamath Basin Area Office. September 30.
- Duff, J.H., K.D. Carpenter, D.T. Snyder, K.K. Lee, R.J. Avanzino, and F.J. Triska. 2009. "Phosphorus, nitrogen legacy in a restoration wetland, Upper Klamath Lake, Oregon." *Wetlands*. 29(2).
- Lyon, S., A. Horne, J. Jordahl, H. Emond, and K. Carlson. 2008. Preliminary Feasibility Assessment of Constructed Treatment Wetlands in the Vicinity of the Klamath Hydroelectric Project. Draft Report. Prepared by CH2M HILL and Alex Horne Associates. Prepared for PacifiCorp Energy. November 2008.
- PacifiCorp. 2007. Application for Water Quality Certification Pursuant to Section 401 of the Federal Clean Water Act for the Relicensing of the Klamath Hydroelectric Project (FERC No. 2082) in Siskiyou County, California. Klamath Hydroelectric Project (FERC Project No. 2082). Prepared for: State Water Resources Control Board, Division of Water Quality, Water Quality Certification Unit, Sacramento. Prepared by: PacifiCorp, Portland, Oregon. February 2007.
- PacifiCorp. 2008. Application for Water Quality Certification Pursuant to Section 401 of the Federal Clean Water Act for the Relicensing of the Klamath Hydroelectric Project (FERC No. 2082) in Siskiyou County, California. Klamath Hydroelectric Project (FERC Project No. 2082). Prepared for: State Water Resources Control Board, Division of Water Quality, Water Quality Certification Unit, Sacramento. Prepared by: PacifiCorp, Portland, Oregon. February 2008.
- Rabe Consulting, Geoengineers, and Watercourse Engineering, Inc. 2008. Keno Reservoir Wetlands Feasibility Study, Phase II: Identification and Assessment of Potential Treatment Wetlands Sites in the Upper Klamath River, Klamath County, Oregon. Prepared for the U.S. Bureau of Reclamation, Klamath Basin Area Office. Proposal No. 07SF200051. June 18.

Regional Water Board. 2007. Water Quality Control Plan for the North Coast Region. North Coast Regional Water Quality Control Board, Santa Rosa CA. January 2007.
http://www.swrcb.ca.gov/northcoast/water_issues/programs/basin_plan/083105-bp/070605_Basin_Plan.pdf

Regional Water Board. 2008. Dissolved Oxygen Water Quality Objective CEQA Scoping Document for Potential Basin Plan Amendment. North Coast Regional Water Quality Control Board, Santa Rosa CA. September 2008.

Regional Water Board. 2009a. Water Quality Restoration Plan for the Klamath River Basin in California: Draft Scoping for TMDL Implementation. Klamath River Basin Temperature, Dissolved Oxygen, Organic Matter and Nutrient TMDLs. North Coast Regional Water Quality Control Board, Santa Rosa CA. REVIEW DRAFT. February 2009.

Regional Water Board. 2009b. Draft Recommendations for AIP Interim Measure 12: Water Quality Monitoring Activities for Year 2009. North Coast Regional Water Quality Control Board, Santa Rosa CA. REVIEW DRAFT. February 2009.