2008 Water Quality Sampling Plan

Klamath Hydroelectric Project
(FERC Project No. 2082)

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CONTENTS

Section **Page**

1.0 INTRODUCTION 1

2.0 WATER QUALITY MONITORING PROGRAM OVERVIEW 2
2.1 DESCRIPTION OF PROGRAM AND ASSOCIATED TASKS 2
2.1.1 Profile or Probe Sampling 2
2.1.2 Water Chemistry Sampling 4
2.1.3 Phytoplankton Sampling 4
2.1.4 Datasonde Deployment 5
2.1.5 Thermograph Deployment 6
2.2 PROGRAM ORGANIZATION AND RESPONSIBILITIES 6
2.3 PROGRAM SCHEDULE AND REPORTING 9

3.0 SAMPLING PROCEDURES AND ANALYTICAL METHODS 11
3.1 SAMPLING METHOD REQUIREMENTS 11
3.2 SAMPLE HANDLING AND CUSTODY REQUIREMENTS 11
3.3 ANALYTICAL METHOD REQUIREMENTS 11

4.0 DATA QUALITY ASSURANCE AND CONTROL 14
4.1 DATA QUALITY ASSURANCE AND CONTROL REQUIREMENTS 14
4.1.1 Accuracy 14
4.1.2 Precision 14
4.1.3 Completeness 15
4.2 INSTRUMENT CALIBRATION AND CALIBRATION FREQUENCY 15
4.3 DATA REVIEW, VALIDATION AND VERIFICATION REQUIREMENTS 15

5.0 REFERENCES 16

1.0 INTRODUCTION

This Sampling Plan is related specifically to the Klamath Hydroelectric Project (Project) 2008 water quality monitoring tasks outlined in PacifiCorp's 2008 Water Quality Studies plan (PacifiCorp 2008a). PacifiCorp is conducting the 2008 water quality monitoring to provide information on water quality conditions in the Project area. The monitoring supports PacifiCorp's on-going assessment of reservoir management plan (RMP) actions (for J.C. Boyle, Copco, and Iron Gate reservoirs) as described in the PacifiCorp (2008b, 2008c) applications for water quality certification for the Project from the California State Water Quality Control Board (State Water Board) and the Oregon Department of Environmental Quality (ODEQ). The 2008 water quality monitoring is a continuation of similar monitoring conducted by PacifiCorp in 2001, 2002, 2003, 2004, 2005 and 2007.

The purpose of this Sampling Plan is to provide a detailed description of the tasks included in the 2008 water quality monitoring program, and to ensure consistency in the practices and procedures to be implemented to accomplish the monitoring tasks. This Sampling Plan describes the specific task elements and activities, field and laboratory methods, and data assessment and reporting procedures to be followed for the 2008 water quality monitoring program. Under this monitoring program, water quality samples and measurements are taken at various river and reservoir sites to assess the water quality conditions in the Project area and to examine trends and relationships in these water quality conditions. All 2008 water quality monitoring task activities will be conducted in compliance with PacifiCorp safety and security practices (PacifiCorp 2007).

2.0 WATER QUALITY MONITORING PROGRAM OVERVIEW

2.1 DESCRIPTION OF PROGRAM AND ASSOCIATED TASKS

The data collected under this water quality monitoring program includes data on a representative suite of physical, chemical, and biological water quality constituents in the Klamath River in the Project vicinity. These physical, chemical, and biological constituents will be measured at frequencies ranging from sub-daily to monthly. Five primary water quality monitoring or sampling tasks are included within the program:

- Profile or Probe Sampling. Bi-weekly and monthly acquisition of physical measurements with multi-probe instrumentation, including water temperature, dissolved oxygen, pH, and specific conductance.
- Water Chemistry Sampling. Bi-weekly and monthly grab samples for laboratory analysis of water chemistry, including nutrients, suspended solids, dissolved organic carbon, turbidity, and alkalinity.
- Phytoplankton Sampling. Bi-weekly and monthly grab samples for laboratory analysis of phytoplankton, including *Microcystis aeruginosa* (MSAE) and microcystin toxin sampling.
- Datasonde Deployment. Deployment of multi-probe instrumentation for acquisition of continuous measurements of water temperature, dissolved oxygen, pH, specific conductance, and blue-green algae (BGA) phycocyanin.
- Thermograph Deployment. Deployment of thermographs for acquisition of continuous water temperature measurements.

Table 2-1 identifies site locations associated with these sampling tasks. River miles for the site locations refer to distance from the mouth (ocean) of the Klamath River.

2.1.1 Profile or Probe Sampling

Measurements for the Profile or Probe Sampling task will be taken at a total of 18 river and reservoir sites as indicated in Table 2-1. These measurements include Profile or Probe Sampling at 13 river and reservoir sites associated with basic water quality monitoring during 2008, and at five additional sites in Copco reservoir for water quality monitoring of SolarBee™ circulators deployed in the upper end of Copco reservoir during 2008.

The 13 basic water quality monitoring sites are the same as previously monitored by PacifiCorp in 2001, 2002, 2003, 2004, 2005 and 2007[1]. Sampling and measurements at these monitoring sites will occur once per month in April, May, November, and December, and every other week in June through October. Samples at the additional five sites in Copco reservoir for monitoring of SolarBee™ circulators sites will be obtained once in May and every two weeks from June through October.

[1] Water quality monitoring was not conducted by PacifiCorp in 2006.

Table 2-1. Sample Sites and Associated Water Quality Tasks During 2008.

Location	River Mile	Profile or Probe Sampling	Water Chemistry Sampling	Phytoplankton Sampling	Datasonde Deployment	Thermograph Deployment
Upper Klamath Lake near Eagle Ridge ramp	UKL			L		
Upper Klamath Lake near Hagelstein Park	UKL			L		
Upper Klamath Lake at Wocus Bay	UKL			L		
Upper Klamath Lake at Pelican Bay ramp	UKL			L		
Link River below Upper Klamath Lake	253.1	M	M	M		
Klamath R. below Keno dam	233.4	M	M	M		T
Klamath R. above J.C. Boyle reservoir	228.2	M	M			T
J.C. Boyle reservoir near dam	224.6	M	M			
Klamath R. below J.C. Boyle powerhouse	220.0	M	M			T
Klamath R. above Copco reservoir	206.4	M	M	M		T
Copco reservoir upper end at Copco Village (S1)	204.0	S		S		
Copco reservoir upper end near "narrows" (S2)	203.0	S		S		
Copco reservoir middle above Mallard Cove (S3)	202.0	S		S		
Copco reservoir at Mallard Cove ramp	201.5			C		
Copco reservoir middle below Mallard Cove (S4)	201.0	S		S		
Copco reservoir middle near Copco Cove (S5)	200.0	S		S		
Copco reservoir at Copco Cove ramp	200.0			C		
Copco reservoir lower end at log boom	198.6	M	M	M		T
Klamath R. below Copco 2 powerhouse	196.3	M	M			
Iron Gate reservoir at Camp Creek area	192.8			C		
Iron Gate reservoir at Williams boat ramp	192.4			C		
Iron Gate reservoir lower end at log boom	190.2	M	M	M		T
Iron Gate powerhouse tailwaters	190.1	M	M	M		
Klamath R. above Iron Gate Hatchery bridge	189.9				D	
Klamath R. at Iron Gate Hatchery bridge	189.7	M	M	M		
Klamath R. at I-5 Rest Area	176.7	M	M	M		T
Klamath R. at Walker Bridge Road	159.0	M	M	M		

Codes: M = sampling associated with basic monitoring as in previous years
S = sampling associated with monitoring of SolarBee circulators in Copco reservoir
L = monitoring of shoreline sites in Upper Klamath Lake
C = monitoring of shoreline sites in Copco and Iron Gate reservoirs
D = datasonde site
T = thermograph sites

The Profile or Probe Sampling will include instantaneous measurements of physical parameters (with multi-probe instrumentation) at each of the sampling sites, including water temperature, dissolved oxygen, pH, and specific conductance. These measurements will be taken at the reservoir sites as profiles (at 1 to 3-meter intervals depending on total depth) and at the river sites just beneath the surface (approximately 0.5 m depth). The measurements are taken by lowering the multi-probe sensor unit (attached by electronic cable to the data-recording base unit) to the depth intervals indicated above. Secchi disk measurements will also be taken at reservoir sites.

2.1.2 Water Chemistry Sampling

Water Chemistry Sampling will occur at a total of 13 river and reservoir sites as indicated in Table 2-1. These 13 river and reservoir sites are associated with basic water quality monitoring during 2008, and include sites as previously monitored by PacifiCorp in 2001, 2002, 2003, 2004, 2005 and 2007. Grab samples for water chemistry at these monitoring sites will occur once per month in April, May, November, and December, and every other week in June through October.

Grab samples for water chemistry analysis at the 13 sites will be done in conjunction with Profile or Probe Sampling at these same sites. The grab samples will be obtained immediately following the physical measurements (under the Profile or Probe Sampling task). The grab samples from the river sites will be taken in the current at approximately 0.5 meter below the surface. The water chemistry samples from J.C. Boyle reservoir will be taken from two depths: at approximately 0.5 meter below the surface and at a depth approximately 1 meter above the bottom. The water chemistry samples from Copco reservoir will be taken from four depths: at approximately 0.5 meter below the surface and at depths of approximately 9, 18, and 27 meters. Water chemistry samples from Iron Gate reservoir will be taken from five depths: at approximately 0.5 meter below the surface and at depths of approximately 10, 20, 30, and 40 meters.

Samples will be obtained using a Kemmerer bottle. The Kemmerer bottle is a cylindrical sampler that can be opened on each end, and is then lowered on a graduated rope to the desired depth, which assures complete flushing of the bottle as it is lowered. Both ends of the bottle are closed by means of a messenger and the undisturbed sample is brought to the surface. Samples are drawn off into sample bottles by means of a valve in the lower end of the sampler.

Water chemistry samples will be analyzed for nutrients, including ammonia (NH3), nitrate + nitrite (NO3 + NO2), total nitrogen (TN), total phosphorous (TP), and orthophosphate (OP). These samples will also be analyzed for total suspended solids (TSS), volatile suspended solids (VSS), dissolved organic carbon (DOC), turbidity (TURB), apparent color (COLORA), and total alkalinity (ALKT). Note: analysis for total organic carbon (TOC) is anticipated to be included in the analysis (probably starting in July) pending determination of appropriate laboratory methodology.

2.1.3 Phytoplankton Sampling

Phytoplankton Sampling will occur at a total of 22 river and reservoir sites as indicated in Table 2-1. This sampling will include taking grab samples for phytoplankton analysis at nine river and reservoir sites associated with basic water quality monitoring during 2008. Grab samples for phytoplankton analysis also will be taken at an additional five sites in Copco reservoir for water quality monitoring of SolarBee™ circulators deployed in the upper end of Copco reservoir during 2008. Phytoplankton Sampling will also occur at an additional four shoreline sample locations in coves in Copco and Iron Gate reservoir (i.e., two cove sites in each reservoir as monitored in previous years by the Karuk Tribe), and four shoreline sample locations in selected coves in the lower (southern) basin of Upper Klamath Lake (UKL).

The nine basic water quality monitoring sites include locations previously monitored by PacifiCorp in 2001, 2002, 2003, 2004, 2005, and 2007. Grab samples for phytoplankton analysis at these monitoring sites will occur once per month in April, May, November, and December, and every other week in June through October. Phytoplankton Sampling at these nine sites will be done in conjunction with Profile or Probe Sampling and Water Chemistry Sampling at these same sites.

Grab samples for phytoplankton analysis at the additional five sites in Copco reservoir for monitoring of SolarBee™ circulators sites will be obtained once in May and every two weeks from June through October. Grab samples from the four shoreline locations in coves in Copco and Iron Gate reservoirs will be obtained once per month in May and November and twice per month in June through October. Grab samples from the four shoreline locations in UKL will be obtained twice per month in June through September.

At the seven river sites associated with basic water quality monitoring, a single phytoplankton grab sample will be taken at each site offshore in the current at approximately 0.5 meters (m) below the surface. At open-water reservoir sites (including two sites associated with basic water quality monitoring and five sites in the vicinity of the SolarBee™ circulators), two phytoplankton grab samples will be taken at each site: (1) a surface grab sample over the top 30 cm depth; and (2) an integrated vertical sample from the surface to a depth of 8 m (approximately the depth of the reservoir's photic zone). At reservoir or UKL shoreline sites (e.g., cove sites), a single phytoplankton grab sample will be taken at each site as a surface grab sample over the top 30 cm depth.

Samples taken at 0.5 meters (m) below the surface will be obtained using the Kemmerer bottle technique as described above under Water Chemistry Sampling. The integrated vertical sample from the surface to a depth of 8 m will be obtained using an integrated hose sampler. The hose sampler consists of clear, flexible laboratory-grade tubing that is weighted on one end and lowered to the 8-m depth. The upper end is clamped at the surface, and the weighted end is lifted to the surface, where the contents of the hose are emptied into a clean churn splitter or other sample container for dispensing into sample bottles.

The 30-cm grab sample will be obtained using a wide-mouth cylinder (8-10 cm diameter). The cylinder includes an open end that is fitted with a removable lid, and a closed end with a single 3/8-inch hole in the closed end. The sample is collected by lowering the cylinder vertically into the water, open end first, until the water in the cylinder reaches a line marked at 30 cm from the inverted open end. While the cylinder is still in place, the lid is placed over the open inverted end, and the cylinder is removed from the water. The hole in the closed end is covered with a finger and the contents of the cylinder are agitated and then dispensed to a sample bottle. At shoreline sites, samples are collected where there is adequate depth to submerge the cylinder without interference from the bottom.

Each phytoplankton grab sample will be analyzed for algae speciation, density, and biovolume, including blue-green algae (BGA) species, notably the potentially toxigenic species *Microcysis aeruginosa* (MSAE). Each phytoplankton grab sample also will be analyzed for chlorophyll-*a* (CHLA) and the presence and concentration of the associated algae toxin microcystin (MCYN).

2.1.4 Datasonde Deployment

A YSI 6600 V2 datasonde with multiple probes will be deployed below the Iron Gate powerhouse tailrace for continuous measurement of water temperature, pH, dissolved oxygen, conductivity, and BGA phycocyanin (an indicator of BGA cell concentration). The datasonde will record in-situ measurements of these parameters at 30-minute intervals from June to mid-December 2008. Recorded data will be downloaded from the datasonde about every two weeks. During data retrieval, the instrument will be calibrated per manufacturer's specifications and procedures.

The data will be tabulated and provisional data will be posted approximately monthly (within about 30 days after collection) on PacifiCorp's Project website (http://www.pacificorp.com/Article/Article1152.html). A final data set will be posted on the website following final review and approval of the complete data record by personnel responsible for data analysis (see Section 2.2).

2.1.5 Thermograph Deployment

During 2008, thermographs will be deployed at seven locations, consisting of five river sites and two reservoir sites. The five river sites include: below Keno dam (RM 233.4), above J.C. Boyle reservoir (RM 228.2), below J.C. Boyle powerhouse (RM 220.0), above Copco reservoir (RM 206.4), and at the I-5 Rest area below Iron Gate dam (RM 176.7). The two reservoir sites include Copco and Iron Gate reservoir locations near the log booms (sites at RM 198.6 and 190.2, respectively).

Thermograph deployments at the five river sites will include individual thermographs anchored securely near the bottom of the channel. Thermograph deployments at the two reservoir sites will consist of vertical thermograph arrays similar to those previously deployed in Copco and Iron Gate reservoirs since 2001. These thermographs will record in-situ measurements of water temperature at 30-minute intervals from June to mid-December 2008. Recorded data will be downloaded from the thermographs approximately monthly.

The data will be tabulated and provisional data will be posted approximately monthly (within about 30 days after collection) on PacifiCorp's website (http://www.pacificorp.com/Article/Article1152.html). A final data set will be posted on the website following final review and approval of the complete data record by personnel responsible for data analysis (see Section 2.2).

2.2 PROGRAM ORGANIZATION AND RESPONSIBILITIES

PacifiCorp is responsible for overall field operations, sampling, and monitoring under this plan, with key assistance from CH2M HILL, Incorporated (Portland and Corvallis, Oregon) and E&S Environmental Chemistry, Incorporated (Corvallis, Oregon). The water quality monitoring program is organized and will be conducted by a team of specialists. Table 2-2 identifies these personnel and describes their specific positions and responsibilities.

Table 2-2. Key Personnel and Their Responsibilities and Contact Information

Personnel	Position	Responsibilities	Contact Information
Linda Prendergast PacifiCorp Energy	PacifiCorp Principal Scientist	Overall responsibility for the 2008 Water Quality Monitoring program. Oversee the Program Manager and Principal Investigator, and ensure that the program is continuously working towards its goals. Communicate and coordinate as needed during the course of the program tasks with Company personnel and stakeholders. Review and approve reports on the status and findings of program tasks, and issue these reports as appropriate to stakeholders.	PacifiCorp Energy 825 NE Multnomah Suite 1500 Portland, OR 97232 (503) 813-6625 Linda.Prendergast@Pacificorp.com
Ken Carlson CH2M HILL Inc.	Program Manager	Responsible for implementing and managing the tasks associated with the 2008 Water Quality Monitoring program. Responsible for development of the Sampling Plan, and any revisions to the Plan. Ensure implementation of the program tasks. Coordinate with the Principal Investigator and Site Technician as needed on implementation of the program tasks. Responsible for ensuring the quality, accuracy, completeness, and timeliness of program reports.	CH2M HILL 2020 SW Fourth Avenue 3rd Floor Portland, OR 97201 (503) 235-5022 ext. 24286 kcarlso2@ch2m.com
Richard Raymond E&S Environmental Inc.	Principal Investigator	Assist Program Manager in development of the Sampling Plan, and any revisions to the Plan. Responsible for field sample and data acquisition for the following tasks: Profile or Probe Sampling, Water Chemistry Sampling, Phytoplankton Sampling (at basic monitoring sites), and Thermograph Deployment. Ensure that water samples for these tasks are properly obtained and delivered in a timely manner to the laboratory for analysis. Recommend and coordinate field sampling schedules and logistics. Assess the field data and lab analysis results for adherence to data quality objectives. Responsible for accurate and timely analysis and reporting of data generated by the study.	E&S Environmental Inc. P.O Box 609 2161 N.W. Fillmore Avenue Corvallis, OR 97339-0609 (541) 758-5518 richard.raymond@esenvironmental.com

Table 2-2. Key Personnel and Their Responsibilities and Contact Information

Personnel	Position	Responsibilities	Contact Information
Kaylea Foster Mason, Bruce and Girard	Site Technician	Assist field sampling, data acquisition, data management, and field sample analysis for the following tasks: Profile or Probe Sampling, Water Chemistry Sampling, Phytoplankton Sampling (at basic monitoring sites), and Thermograph Deployment. Responsible for field sample and data acquisition for the following tasks: Datasonde Deployment, Phytoplankton Sampling (at SolarBee™ monitoring sites, and at reservoir and lake shoreline sites). Ensure that water samples for these tasks are properly obtained and delivered in a timely manner to the laboratory for analysis. Responsible for instrument calibration and maintenance, and data retrieval from the Datasonde Deployment. Ensure timely transmittal of data to the Program Manager.	Mason, Bruce and Girard Yreka Office 213 W. Miner, Suite A Yreka, CA 96097 (530) 842-1760 kfoster@masonbruce.com
Tyler Macpherson E&S Environmental	Environmental Field Technician	Assist and support the Principal Investigator as needed in field sampling, data acquisition, data management, and field sample analysis.	E&S Environmental Inc. P.O Box 609 2161 N.W. Fillmore Avenue Corvallis, OR 97339-0609 (541) 758-6305 Tyler.macpherson@esenvironmental.com
Kathy McKinley CH2M HILL Inc.	Lead Laboratory Analysis Specialist	Responsible for the laboratory analysis of field samples. Responsible for implementing laboratory quality control procedures; monitor instrument maintenance, calibration, and reliability; audit documentation from sample analysis. Ensure timely reporting of lab analysis results to the Program Manager.	CH2M HILL Inc. Applied Sciences Laboratory 2300 NW Walnut Blvd. Corvallis, OR 97330-3538 (541) 752-4271 ext. 3144 kmckinle@ch2m.com

2.3 PROGRAM SCHEDULE AND REPORTING

Table 2-3 provides the anticipated study schedule for various sampling and reporting tasks and milestones. A Final Technical Report describing the 2008 data will be completed by March 2009. During the course of the program, technical memorandums will be prepared on a rolling basis and distributed to the Klamath Blue Green Algae Working Group that summarize the results of the most recent MSAE and microcystin sample results.

Table 2-3. Anticipated Schedule of Study Tasks (See Previous Sections of the Sampling Plan for Task Details)

Period of Completion (Week of)	Task
April 28, 2008	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites
May 19	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites
June 2	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
June 9	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites
June 16	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites Deployment of Datasonde and Thermographs
June 23	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde Maintenance and Data Retrieval
June 30	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
July 7	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde and Thermographs Maintenance and Data Retrieval
July 14	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
July 21	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde Maintenance and Data Retrieval
July 28	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
August 4	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde and Thermographs Maintenance and Data Retrieval
August 11	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
August 18	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde Maintenance and Data Retrieval

Table 2-3. Anticipated Schedule of Study Tasks (See Previous Sections of the Sampling Plan for Task Details)

Period of Completion (Week of)	Task
August 25	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
September 1	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde and Thermographs Maintenance and Data Retrieval
September 8	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
September 15	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde Maintenance and Data Retrieval
September 22	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites and at UKL Sites
September 29	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde and Thermographs Maintenance and Data Retrieval
October 6	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites
October 13	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde Maintenance and Data Retrieval
October 20	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites
October 27	Profile/Probe Sampling and Phytoplankton Sampling at Copco Circulator Sites Datasonde and Thermographs Maintenance and Data Retrieval
November 10	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites Phytoplankton Sampling at Reservoir Shoreline Sites
November 17	Datasonde Maintenance and Data Retrieval
December 1	Datasonde Maintenance and Data Retrieval
December 8	Profile/Probe Sampling, Water Chemistry Sampling, and Phytoplankton Sampling at Basic Monitoring Sites
December 15	Datasonde and Thermographs Retrieval
March 2009	Technical Report of 2008 Data

3.0 SAMPLING PROCEDURES AND ANALYTICAL METHODS

This section describes the specific procedures for field collection of grab samples and probe measurements, and subsequent sample handling and custody requirements to be followed for the 2008 water quality monitoring program. This section also describes the specific laboratory analytical methods to be followed for the 2008 water quality monitoring program.

3.1 SAMPLING METHOD REQUIREMENTS

The "Standard Operating Procedure for Water Quality Grab Sampling" (PacifiCorp 2008d) describes the protocols for field collection of grab samples under the Water Chemistry Sampling and Phytoplankton Sampling tasks. The grab samples will be collected using a clean sample bottle, churn splitter, Kemmerer sampler, integrated hose sampler, or other sampling devices as appropriate to the site. PacifiCorp (2008d) instructs how the grab sampling will be performed and associated procedures for documenting the field activities.

Multi-probe instruments (i.e., In Situ 9000, Hydrolab H20, YSI 6920, YSI 6600 V2, or similar) will be used to measure the physical parameters (pH, specific conductance, dissolved oxygen, and water temperature) of the sampled water. Multi-probe instruments will be calibrated and maintained, and measurements taken according to manufacturer specifications. Copies of manuals and instructions from the manufacturer are kept in the possession of personnel responsible for the Profile or Probe Sampling tasks (see Table 2-2).

3.2 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample bottle requirements, preservatives, and hold times for laboratory analysis of water quality parameters are based on laboratory analytical requirements and are listed in Table 3-1. Water samples will be collected in polyethylene or glass bottles as supplied by the laboratory and preserved according to the requirements of the specific laboratory analytical methods (see Section 3.3). Grab samples collected will be labeled and processed in the field according to procedures described in PacifiCorp (2008d).

After collection, samples are kept in coolers on ice until delivered to the laboratory. All samples collected in the field require Chain of Custody (COC) forms. The COC forms will clearly document all the samples collected during that sampling period, associated sample identification numbers, and the date and time of collection for each sample. Field observations and measurements will be documented in the field while sampling in notebooks or data sheets as necessary (PacifiCorp 2008d). The COC form may be completed at the end of the day when sampling is finished. The COC form is shipped with the samples to the analytical laboratory (CH2M HILL Applied Sciences Laboratory, Corvallis, Oregon).

3.3 ANALYTICAL METHOD REQUIREMENTS

The specific Water Chemistry Sampling laboratory analytical methods and method detection limits (MDL) are listed in Table 3-2. The analyses selected were based on previous water quality monitoring and analytical laboratory recommendations. CH2M HILL Applied Sciences Laboratory located in Corvallis, Oregon will be responsible for analyzing the water samples for total phosphorous (TP), total nitrogen (TN), ammonia (NH3), nitrate + nitrite (NO3 + NO2), dissolved organic carbon (DOC), total suspended solids (TSS), volatile suspended solids (VSS), and total alkalinity (ALKT). Orthophosphate (OP), turbidity (TURB), and apparent color (COLORA) will be analyzed by E&S Environmental Chemistry on site using portable field instrumentation. Note: analysis for total organic carbon (TOC) is

anticipated to be included in the analysis (probably starting in July) pending determination of appropriate laboratory methodology.

The specific Phytoplankton Sampling laboratory analytical methods also are listed in Table 3-2. CH2M HILL Applied Sciences Laboratory will be responsible for analyzing the water samples for microcystin (MCYN) and chlorophyll-*a* (CHLA). Algae speciation, cell count, and biovolume analysis (PPLK) will be conducted by Aquatic Analysts of White Salmon, Washington.

Table 3-1. Sample bottle requirements, preservatives and hold times for laboratory analysis of 2008 water quality sampling parameters[2].

Parameters	Field Filtered	Container	Preservatives	Hold Time
Ammonia, Nitrate+nitrite, Total phosphorus	N	500 mL poly Clear	4°C, 2 ml H_2SO_4	28 days
Total nitrogen	N	250 mL poly clear	4°C, 2 ml H_2SO_4	28 days
Total suspended solids, Volatile suspended solids	N	mL poly Clear	4°C, none	7 days
Dissolved organic carbon[3]	Y	60 mL Glass Amber	4°C, add H_3PO_4 to pH < 2	7 days
Total alkalinity	N	500 mL poly Clear	4°C, none	14 days
Chlorophyll-*a*	N	250 mL HDPE Amber	$MgCO_3$, 1 mL, 4°C, keep in dark	NA[4]
Phytoplankton analysis	N	250 ml HDPE Amber	4°C, 5 ml Lugols	NA[4]
Microcystin	N	60 mL amber glass vial	4°C, none	7 days

The analysis methods listed for the parameters listed in Table 3-2 include specific methods approved by the Environmental Protection Agency (EPA 2007) and *Standard Methods Standard Methods for the Examination of Water and Wastewater* (SM) (APHA et al. 2005). Descriptions of the specific procedures for the EPA methods are kept at the laboratory and can be found at the EPA web site at http://www.epa.gov/waterscience/methods/method/index.html. Descriptions of the specific procedures for the SM methods are kept at the laboratory and can be found at http://www.standardmethods.org/.

The laboratory analysis of phytoplankton speciation and density is done on prepared microscope slides of filtered samples using phase contrast microscopy. Species are counted as algal units of cell, filament, or colony depending on the natural growth form of the species. BGA species are enumerated as individual cells. Algal forms are identified to species or otherwise to the lowest practicable taxonomic level. Biovolumes are estimated by multiplying the cell counts by the average geometric dimensions of the cells for a given phytoplankton taxa.

[2] The parameters water temperature, dissolved oxygen, pH, specific conductance, orthophosphate, turbidity, and apparent color are not listed in this table because they will be analyzed in the field using portable field instrumentation.

[3] Total organic carbon (TOC) is anticipated to be included in the analysis (probably starting in July) pending determination of appropriate laboratory methodology.

[4] Preserved algae speciation and chlorophyll-*a* samples do not have a specified holding time. In this study, these samples will be processed as soon as practicable after sampling.

Table 3-2. Analytical methods for 2008 water quality sampling parameters.

Parameter Name	Parameter ID	Analysis Method	MDL	Units
Water temperature	TEMP	Measurement using in-situ probe[5]	0.1	^{0}C
Dissolved oxygen	DOCON	Measurement using in-situ probe[5]	0.1	mg/L
pH	PH	Measurement using in-situ probe[5]	0.1	units
Specific conductance	SPC	Measurement using in-situ probe[5]	1	µS/cm
Total alkalinity	ALKT	Lab analysis per EPA 310.1	5.0	mg/L
Color	COLORA	Portable field spectrophotometer using the platinum-cobalt standard method (SM 2120)	5	PCU
Turbidity	TURB	Field turbidimeter using the nephlometric method (EPA 1992)	0.1	NTU
Total nitrogen	NT	Lab analysis per SM 4500-N B	0.01	mg/L
Ammonia nitrogen (as N)	NH3	Lab analysis per EPA 350.1	0.01	mg/L
Nitrate+nitrite nitrogen (as N)	NO3+NO2	Lab analysis per EPA 353.2	0.002	mg/L
Total phosphorus (as P)	PT	Lab analysis per EPA 365.1	0.02	mg/L
Orthophosphate (as P)	PO4	Portable field spectrophotometer using the ascorbic acid method (EPA 365.1)	0.02	mg/L
Dissolved organic carbon[3]	DOC	Lab analysis per EPA 415.1	0.05	mg/L
Total suspended solids	TSS	Lab analysis per EPA 160.2	2.0	mg/L
Volatile suspended solids	VSS	Lab analysis per EPA 160.4	2.0	mg/L
Chlorophyll-*a*	CHLA	Lab analysis per SM 10200H.3	0.1	µg/L
Phytoplankton analysis	PPLK	Lab analysis per SM 10200F	NA	count
Microcystin	MYCN	Lab analysis per ELISA	0.16	µg/L

The analysis method for microcystin (MCYN) is based on the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method using the EnviroLogix QuantiPlate Kit for Microcystins. This test method does not distinguish between the specific microcystin congeners, but detects their presence to differing degrees. That is, ELISA test results yield one value as the sum of all measurable microcystin variants. Descriptions of the specific procedures for the EnviroLogix QuantiPlate Kit can be found at http://www.envirologix.com/library/ep022insert.pdf.

[5] Measurements taken *in situ* in the field using calibrated probes (In Situ 9000, Hydrolab H20, YSI 6920, YSI 6600 V2, or similar).

4.0 DATA QUALITY ASSURANCE AND CONTROL

4.1 DATA QUALITY ASSURANCE AND CONTROL REQUIREMENTS

Data quality objectives are established for the quality assurance (QA) and quality control (QC) of samples submitted to the laboratories for analysis. To check analytical accuracy, precision, and completeness (as described in the following sub-sections), field sampling personnel will incorporate at least one blank sample, one duplicate sample, and one spike reference sample per sampling event. Field sampling personnel will label these external QA check samples with identifications similar to regular or production samples[6]. All external QA samples submitted to the laboratories are blind samples (sample is not identified as an external check sample). Analysis results from these QA samples will establish whether data generated from the laboratory analyses are reliable. For this program, the data quality measures and objectives are described in the following sub-sections.

CH2M HILL Applied Sciences Laboratory Aquatic Analysts also will incorporate their own internal laboratory QA/QC procedures to ensure data reliability. The specific QA/QC procedures used by the CH2M HILL Applied Sciences Laboratory and Aquatic Analysts for this program can be found in their QA/QC manuals.

4.1.1 Accuracy

Accuracy is a measure of the bias inherent in a system or the degree of agreement of a measurement with an accepted reference or true value. It is most frequently expressed as percent recovery. Percent recovery (% Rec.) is a measure of accuracy determined from comparison of a reported spike value to its true spike concentration:

Percent recovery (% Rec.) = ((Observed conc. – Sample conc.)/(True spike conc.)) x 100

For spike sample analysis, Recovery should be 80 to 120 percent. This limit does not apply when sample value exceeds spike concentration by more than five times. For reference materials, Recovery should be 80 to 120 percent of certified value for values more than 20 times the Reporting Limit (see Table 3-2). For values less than 20 times the Reporting Limit, recovery should be $\pm$ two times the Reporting Limit from the certified value. Blank concentration should be less than 10 percent of lowest sample concentration or less than or equal to two times the Reporting Limit.

4.1.2 Precision

Precision is a measure of the mutual agreement (or variability) among individual measurements of the same property, usually under prescribed similar conditions. Precision is usually expressed in terms of relative percent difference (RPD), but can be expressed in terms of range. The RPD for of a duplicate set of results X1 and X2 is calculated as:

RPD = ((X1 – X2)/((X1 + X2)/2)) x 100

The range is the difference between the largest and smallest numbers in a set of numbers.

[6] Sample terminology is as follows: the QA duplicate sampling consists of a “regular sample” and its sister “duplicate sample”; all other non-QA sampling consists of a single “production sample”.

For duplicates, the RPD should be 20 percent or less for values greater than five times the Reporting Limit. For values less than or equal to five times the Reporting Limit, values may vary ± the Reporting Limit.

4.1.3 Completeness

Completeness is the measure of the number of valid measurements (V) obtained from a measurement system compared to the total number of measurements (n) that was expected to be obtained under correct normal sampling conditions. It is usually expressed as a percentage:

Completeness (%) = V/n x 100

For sampling and analysis under this program, a completeness objective of at least 90 percent has been established.

4.2 INSTRUMENT CALIBRATION AND CALIBRATION FREQUENCY

CH2M HILL Analytical Services Laboratory performs calibrations of laboratory instruments following the procedures and frequencies stated in the analytical methods for each parameter. Multi-probe instruments used in the field for in-situ measurements of physical parameters (pH, specific conductance, dissolved oxygen, and water temperature) will be calibrated according to manufacturer specifications and procedures. Copies of manuals and instructions from the manufacturer are kept in the possession of personnel responsible for the Profile or Probe Sampling tasks (see Table 2-2).

4.3 DATA REVIEW, VALIDATION AND VERIFICATION REQUIREMENTS

The Principal Investigator will review and verify all data generated from this program. The laboratory's QA samples must meet certain levels of acceptability when analyzed with the production samples (as described in sub-section 4.1 above). The data verification process includes checking these laboratory QA sample results to ensure they are within acceptable ranges. In order to ensure data quality, the Principal Investigator will assess laboratory data packages to determine if all samples were analyzed within the holding times. The Principal Investigator will also perform calculations and determinations for accuracy, precision, and completeness and implement corrective actions if needed.

If data quality indicators do not meet the program's specifications, data will be flagged. The flagged data will be explained with a note that will accompany the data in any database spreadsheets and reports pending resolution. The cause of data anomalies will be evaluated. If the cause is due to equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is determined to be a sampling error, sampling procedures will be reinforced. If the problem is laboratory-related, the Lead Laboratory Analysis Specialist will be contacted and corrective actions implemented. Any limitations on data use or discarding of data will be detailed final reports and other data documentation as needed.

5.0 REFERENCES

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