

Revised Study Plan
Boundary Hydroelectric Project (FERC No. 2144)

Study No. 5
Water Quality Constituent and Productivity Monitoring

Seattle City Light

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Study No. 5 – Water Quality Constituent and Productivity Monitoring

1.0 INTRODUCTION

The application for certification under Section 401 of the Clean Water Act (401 certification) requires characterization of existing water quality conditions in the Boundary Project area and an assessment of whether water quality meets Washington Department of Ecology (Ecology) regulatory standards. In addition, water quality parameters, including temperature, pH, dissolved oxygen (DO), nutrients, and primary productivity and zooplankton abundance, are important factors affecting the quality of fish habitat. Water quality issues in Boundary Reservoir appear to be limited to pH, total dissolved gas (TDG), water temperature, and toxics. Existing information does not indicate exceedances of Ecology criteria for other water quality parameters.

2.0 STUDY PLAN ELEMENTS

2.1. Nexus between Project Operations and Effects on Resources

The operation of the Boundary Project (Project) has the potential to impact water quality in the Pend Oreille River within the Project area. In support of 401 certification and FERC relicensing processes, potential impacts must be evaluated. Although some historical information exists, additional and ongoing data on specific water quality constituents are needed to evaluate potential Project effects on water quality. In addition, data on the productivity of the reservoir are needed to support evaluations of potential Project effects on aquatic habitat and fauna.

2.2. Agency Resource Management Goals

In addition to providing information needed to characterize Project effects, the water quality study will provide information to help agencies with jurisdiction over water quality resources in the Project area identify appropriate conditions for the new Project license pursuant to their respective mandates. Boundary Project studies are specifically designed to meet Federal Energy Regulatory Commission (FERC) relicensing requirements, but may also be relevant to recent or ongoing management activities by other entities. A brief description of the other resource management goals related to water quality, by entity, follows.

Washington Department of Ecology (Ecology)

Washington State water quality standards are summarized in Table 2.2-1. This table presents two sets of standards, the 1997 federally approved standards and revised standards adopted by Ecology in July of 2003.

Table 2.2-1. Applicable Washington State surface water quality standards for the Pend Oreille River between the Idaho border and the Canadian border (WAC 1997; WAC 2003).

Parameter	1997 Standard (Class A) ¹	2003 Standard (salmon and trout spawning, non-core rearing, and migration) ²	Applicable Standard
Dissolved Oxygen	Levels shall exceed 8.0 mg/L	Levels shall exceed 8.0 mg/L	1997 Standard
Fecal Coliform (Primary Contact Recreation category)	Not to exceed a mean value of 100 colonies/100 ml with no more than 10 percent of all samples exceeding 200 colonies/100 ml	Not to exceed a mean value of 100 colonies/100 ml with no more than 10 percent of all samples exceeding 200 colonies/100 ml	2003 Standard
Temperature	Special Condition: Not to exceed 20°C due to human activities. If natural conditions exceed 20°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed $t=34/(T+9)$	Not to exceed 1-DMax of 20.0°C due to human activities. If natural conditions exceed 1-DMax of 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed $t=34/(T+9)$	1997 Standard
Total Dissolved Gas	Not to exceed 110 percent of saturation at any point of sample collection	Not to exceed 110 percent of saturation at any point of sample collection	1997 Standards
pH	Within 6.5-8.5 with human caused variation within the above range of less than 0.5 units	Within 6.5-8.5 with human caused variation within the above range of less than 0.5 units	1997 Standards
Toxic Substances (Aquatic Life/Public Health category)	Must be below those which have the potential to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon that water, or adversely affect public health.		1997 Standards
Turbidity	Should not exceed either a 5 NTU increase over background when the background is 50 NTU or less, or a 10 percent increase in turbidity when the background is more than 50 NTU	Should not exceed either a 5 NTU increase over background when the background is 50 NTU or less, or a 10 percent increase in turbidity when the background is more than 50 NTU	1997 Standards

Notes:

- Chapter 173-201A WAC Water Quality Standards for Surface Waters of the State of Washington. November 1997.
- Chapter 173-201A WAC Water Quality Standards for Surface Waters of the State of Washington. July 2003.

The 2003 revised standards cannot be used for regulating federal actions pursuant to the Clean Water Act until approved by the U.S. Environmental Protection Agency (EPA). EPA is in the process of reviewing these standards and in February 2005 provided a partial approval. In a letter dated March 23, 2006, EPA formally disapproved of parts of Washington State's 2003 water quality standards because they were considered by EPA to be inadequate for protecting salmon and bull trout in certain streams and rivers. However, this disapproval relates only to temperature standards and does not affect any specific reaches of the Pend Oreille River. Ecology is in the process of proposing a new set of rules to remedy the deficiencies identified by EPA. In the meantime, Ecology is currently using the parts of the 2003 rule that EPA has approved, but employs the 1997 rule for the parts of the 2003 rule that EPA has not yet approved (i.e., temperature). The last column of Table 2.2-1 identifies the standards that are currently applicable. Both standards specify that all reservoirs with a mean detention time of 15 days or less are classified the same as the river section in which they are located. Boundary Reservoir has a residence time of less than 4 days, and is therefore categorized under the Pend Oreille River water quality standards.

U.S. Environmental Protection Agency (EPA)

The Clark Fork – Pend Oreille Basin Water Quality Study: A Summary of Findings and a Management Plan was prepared in 1993 as a cooperative effort among the states of Montana, Idaho, and Washington, with assistance from the EPA (EPA 1993). This report summarizes three years of water quality research in the Clark Fork-Pend Oreille River basin and provides a management plan for protection of the basin's water quality. This report identifies management objectives for the Clark Fork River basin, Lake Pend Oreille, and the Pend Oreille River basin. Information from the Boundary Project water quality study will be applicable to the following management plan objective: Improve Pend Oreille River water quality through macrophyte management and tributary nonpoint source controls. Actions as related to this objective include:

1. Develop and maintain programs to educate the public on their role in protecting and maintaining water quality
2. Control Eurasian watermilfoil by education, rotovation, and research into alternative methods
3. Establish and maintain a water quality monitoring network to monitor effectiveness and trends and to better identify sources of pollutants

Water Resource Inventory Area (WRIA) 62

Numerous agencies and stakeholders in 1998 formed the Water Resource Inventory Area (WRIA) 62 planning unit, the goal of which is to “develop strategies that will balance competing demands for water, while at the same time addressing local concerns, preserving and enhancing the health of the watershed and considering the economic stability of the watershed.” In January of 2005, a Watershed Management Plan for WRIA 62 was completed (Golder Associates 2005). This plan identified the following five goals and related objectives for water quality:

- WQUAL-1: WRIA-wide coordination of water quality monitoring.
- WQUAL-2: Watershed Planning Implementing Body support of actions that aim to reduce Eurasian watermilfoil and other aquatic nuisance weeds in WRIA 62.
Objective: Reduce Eurasian watermilfoil and other aquatic nuisance weeds in WRIA 62
- WQUAL-3a: Watershed Planning Implementing Body to participate in (interact and provide input to) the TMDL process for tributary streams that originate within WRIA 62.
Objective: Remove tributary streams in WRIA 62 from the 3030(d) list of impaired waters by meeting State and tribal (where appropriate) water quality standards in impaired tributary streams.
- WQUAL-3b: Watershed Planning Implementing Body to participate in (interact and provide input to) the TMDL process for the mainstem of the Pend Oreille River.
Objective: Meet State and tribal (where appropriate) water quality standards in the mainstem Pend Oreille River.
- WQUAL-5: Protect water bodies of high water quality and improve water quality of impaired water bodies.
Objective: Maintain compliance with state water quality standards and prevent degradation of waters that meet or exceed state water quality standards in WRIA 62.

Columbia River Subbasin Plans

In 2004, the Northwest Power Planning Council completed the Intermountain Province Subbasin Plan. This plan identifies recommended management actions that will be used to guide the review, selection, and funding of projects in Columbia River subbasins (GEI 2004). The management plan objectives identified in the subbasin plan as related to water quality in the Pend Oreille River are outlined below.

- Subbasin Objective 1B2: Improve water quality to meet or exceed applicable water quality standards in the Subbasin.
Strategy c: Identify pollution sources, causes, and constituents on tributaries and mainstem Pend Oreille River; determine and implement actions necessary to eliminate or mitigate effects.
Proposed Strategy e: Continue monitoring the water quality of Lake Pend Oreille, Clark Fork River and Pend Oreille River to insure it meets State and Federal standards.
- Subbasin Objective 1B9: Control the spread (allow 0 acres) of Eurasian watermilfoil in the subbasin
Strategy a: Inventory and map locations of milfoil occurrence.
Strategy b: Evaluate the impact of extended dewatering and exposure to freezing temperatures on milfoil shoots.

The Boundary water quality study will provide information relevant to the objectives and strategies described above.

USDA Forest Service (USFS)

The Colville National Forest is located within the Pend Oreille River basin and as such, the USFS is a participating stakeholder in the relicensing of the Boundary Project. The Land and Resource Management Plan was developed by the USFS and completed in 1988 (USFS 1988). This plan identifies five management activities in the soil and water division including:

1. Coordinate with other resources to provide support and advice that helps protect the soil and water resources.
2. Monitor the effect of the Forest Plan activities on the soil and water resources.
3. Restore damaged soil and water resources.
4. Work with Washington State Department of Ecology or others as needed to secure water rights.
5. Coordinate with other agencies or interested parties.

Specific standards and guidelines related to surface water quality include:

1. Maintain water quality parameters within the range of good fish habitat conditions, and within State water quality standards:
 - *Temperature* – less than 16 degrees Celsius, provided that temperature increases resulting from a non-point source will not exceed 2.8 degrees Celsius above the natural base-line of the stream.
 - *pH* – Natural levels are normally between 6.5 and 9.0 on the Colville National Forest. Man-caused variation will not exceed 0.2 units.
 - *Dissolved oxygen* – more than 9.5 mg/L
 - *Total dissolved gas* – not to exceed 110 percent of saturation
 - *Turbidity* – changes not to exceed 5 NTU where base-line turbidity is less than 50 NTU; changes not to exceed a 10 percent increase where base-line turbidity is more than 50 NTU.
2. Complying with State requirements in accordance with the Clean Water Act for protection of waters of the State of Washington through planning, application, and monitoring of Best Management Practices in conformance with the Clean Water Act, regulations, and federal guidance issued thereto.
3. In watersheds where project scoping identifies an issue or concern regarding the cumulative effects of activities on water quality or stream channels, a cumulative effects assessment will be made. This will include land in all ownerships in the watershed. Activities on National Forest System lands in these watersheds should be dispersed in time and space to the extent practicable, and at least to the extent necessary to meet management requirements. On intermingled ownerships, coordinate scheduling efforts to the extent practicable.

US Fish and Wildlife Service (USFWS)

The US Fish and Wildlife Service is responsible for some federally listed species, including threatened bull trout (*Salvelinus confluentus*), migratory birds, and the habitats that support them. A short reach of Sullivan Creek, commencing at its confluence with the Pend Oreille River, has been designated as critical habitat for bull trout. The draft Bull Trout Recovery Plan identifies as a recovery objective, “restore and maintain suitable habitat conditions for all bull trout life history stages and strategies,” and identifies investigation and improvement of water quality as a specific action to address this objective.

2.3. Study Goals and Objectives

The goals of the water quality study are to evaluate existing water quality conditions in and immediately downstream of Boundary Reservoir in support of the application for 401 certification and Fish and Aquatic resource studies. These goals will be accomplished by two objectives. The first is to characterize water quality conditions in and immediately downstream of Boundary Reservoir to determine if the Project meets Ecology’s water quality standards in support of the 401 application. The second is to collect nutrient, primary productivity, and zooplankton data in support of the assessment of reservoir productivity being conducted as part of the Fish and Aquatic resource studies. To meet this objective, data will be collected in both the pelagic and littoral zones of the reservoir.

2.4. Need for Study

Summary of Existing Information

Long-term water quality data are limited for most of Boundary Reservoir, but some long-term water quality data have been collected in the Pend Oreille River upstream of Boundary Reservoir and at Metaline Falls. Data collected in the lower Pend Oreille River during 1962 and 1963 (pre-Boundary Project), show that pH ranged from 7.6 to 8.2 (Pine et al. 1964). Ecology has been collecting pH measurements at Metaline since 1949 (Ecology 2005), and of the 149 readings taken at this site 9 (6 percent) exceeded the state water quality standard of 8.5 pH units.

The Tri-State Water Quality Council compiled a status and trends report summarizing nutrient data collected from 1984 through 2002 in the Clark Fork/Pend Oreille Watershed (Land & Water Consulting 2004). The report’s results indicate a slight decreasing trend over the collection period in total phosphorus, soluble reactive phosphorus, total nitrogen, and soluble inorganic nitrogen measured at Newport and a slight decreasing trend for total nitrogen at Metaline.

The majority of nutrient loading in the Pend Oreille River is associated with water exiting Lake Pend Oreille (EPA 1993). Water and nutrient inputs from Washington tributaries account for less than 4 percent of the Pend Oreille River flow and nutrient load (EPA 1993). Of this 4 percent, approximately 75 percent of the nutrient loading comes from three sources: Newport wastewater treatment plant, Calispell Creek, and Trimble Creek (EPA 1993). These three sources are all located upstream of Boundary Reservoir (for more detail on existing nutrient data refer to section 4.4.5.3.7 of the PAD, SCL 2006a).

Water quality data more specific to Boundary Reservoir have been collected by Seattle City Light (SCL) over the past few years. The first study, Herrera (1999), involved *in situ* and laboratory analyses of water quality constituents in October 1996 and October 1998. Water quality data, including total phosphorus, soluble reactive phosphorus, ammonia, nitrate-nitrite, total Kjeldahl nitrogen, chlorophyll *a*, phaeophyton *a*, secchi depth, and temperature and DO profiles, were collected at four stations longitudinally distributed along the length of the reservoir. The Herrera (1999) study found that Boundary Reservoir has low to moderate nutrient enrichment (phosphorus and nitrogen) and that its trophic status is meso-oligotrophic (Herrera 1999). Comparison of the 1996 and 1998 data indicates that phosphorus levels remained the same, but nitrogen and chlorophyll *a* concentrations increased over the two-year period. The study showed that total phosphorus concentrations were below 20 µg/L. Temperature and DO profile data indicate little variation between surface and bottom waters during fall, and little variation between downstream and upstream monitoring stations.

SCL contracted with Taylor Associates to conduct water quality studies beginning in 2004 (Taylor Associates 2005a, Taylor Associates 2006). Taylor Associates collected water quality data at eight permanent temperature monitoring stations and six water quality monitoring stations in the summer of 2004. Water quality monitoring consisted of profile measurements of temperature, DO, pH, and conductivity. Similar studies were conducted in 2005 and 2006. The 2004 and 2005 studies show that DO concentrations ranged from 8.5 mg/L to 9.5 mg/L and that there was little vertical or longitudinal variation in DO concentrations. These studies showed that pH exceeds water quality standards at many of the sites. In general, the exceedances are within one tenth of a pH unit of the standard. However, on some occasions pH was measured as high as 9.6. For more detailed information on existing water quality data, refer to section 4.4.5.3.9 of PAD.

In 2000, a WDFW study collected temperature, DO, pH, conductivity, turbidity, chlorophyll *a*, phytoplankton, periphyton, zooplankton, and benthic macroinvertebrates in Boundary Reservoir (McLellan 2001). This study showed that samples collected in August and October 2000 had an average chlorophyll *a* concentration of 1.05 µg/L, a concentration indicative of low productivity. The authors attributed the low productivity to the rapid turnover rate of the reservoir. The phytoplankton species observed were those associated with low zooplankton grazing pressure, indicating that zooplankton abundance in Boundary Reservoir was also low. McLellan (2001) sampled zooplankton in Boundary forebay and at the Metaline Falls Bridge during 2000. They found 20 species of zooplankton and an average density of 5 organisms/L, a low density compared to other Northwest lakes and reservoirs (for more detail on existing chlorophyll *a*, phytoplankton, and zooplankton data refer to section 4.4.5.3.5 of the PAD).

Need for Additional Information

As noted above, the goals of the water quality study are to collect water quality information that will be used to evaluate existing water quality conditions for the 401 certification application and support aquatic resource studies. Although SCL has been collecting water quality data since 2004, nutrient data have only been collected in 2006 and only limited chlorophyll *a*, phytoplankton, and zooplankton data have been collected; these parameters will be addressed as part of the study outlined herein.

Water quality parameters, including pH, DO, nutrients, and phytoplankton/zooplankton abundance, are important factors determining the quality of fish habitat. Additional data are needed to characterize these and other parameters in and immediately downstream of Boundary Reservoir to assess fish habitat suitability. In addition, water quality data are needed to assess Project effects on primary and secondary production in the reservoir.

2.5. Detailed Description of Study

Study Area

Water quality monitoring will be conducted in and immediately downstream of Boundary Reservoir. A site map with preliminary sampling locations for sampling in 2007 and 2008 is provided in Figure 2.5-1. (See section 1.3 of the Proposed Study Plan [PSP; SCL 2006b] for a description of the Boundary Project location, facilities, and reservoir.)

Proposed Methodology

The water quality monitoring will consist of two components, one year of water quality and productivity data collection and seasonal zooplankton drift data collection. Both of these components are described in detail below.

The water quality constituent monitoring will consist of data collection at eight sampling stations during eight months of a one-year period. Monthly samples (grab samples and *in situ* data collection) will be collected from May through September 2007, in November 2007, and in January and March 2008. Water quality monitoring will include the following variables: temperature, pH, DO, conductivity, Secchi depth, chlorophyll *a*, nutrients, zooplankton, hardness, and turbidity.

Water Quality and Productivity Constituents

Chlorophyll *a* measurements will be used as an indicator of phytoplankton productivity. Phytoplankton production is limited when retention time is less than 3 days (Uhlmann 1971). Boundary Reservoir on average has a retention time of less than 2 days. Given this short retention time and the observed low chlorophyll *a* concentrations, phytoplankton productivity appears to be low.

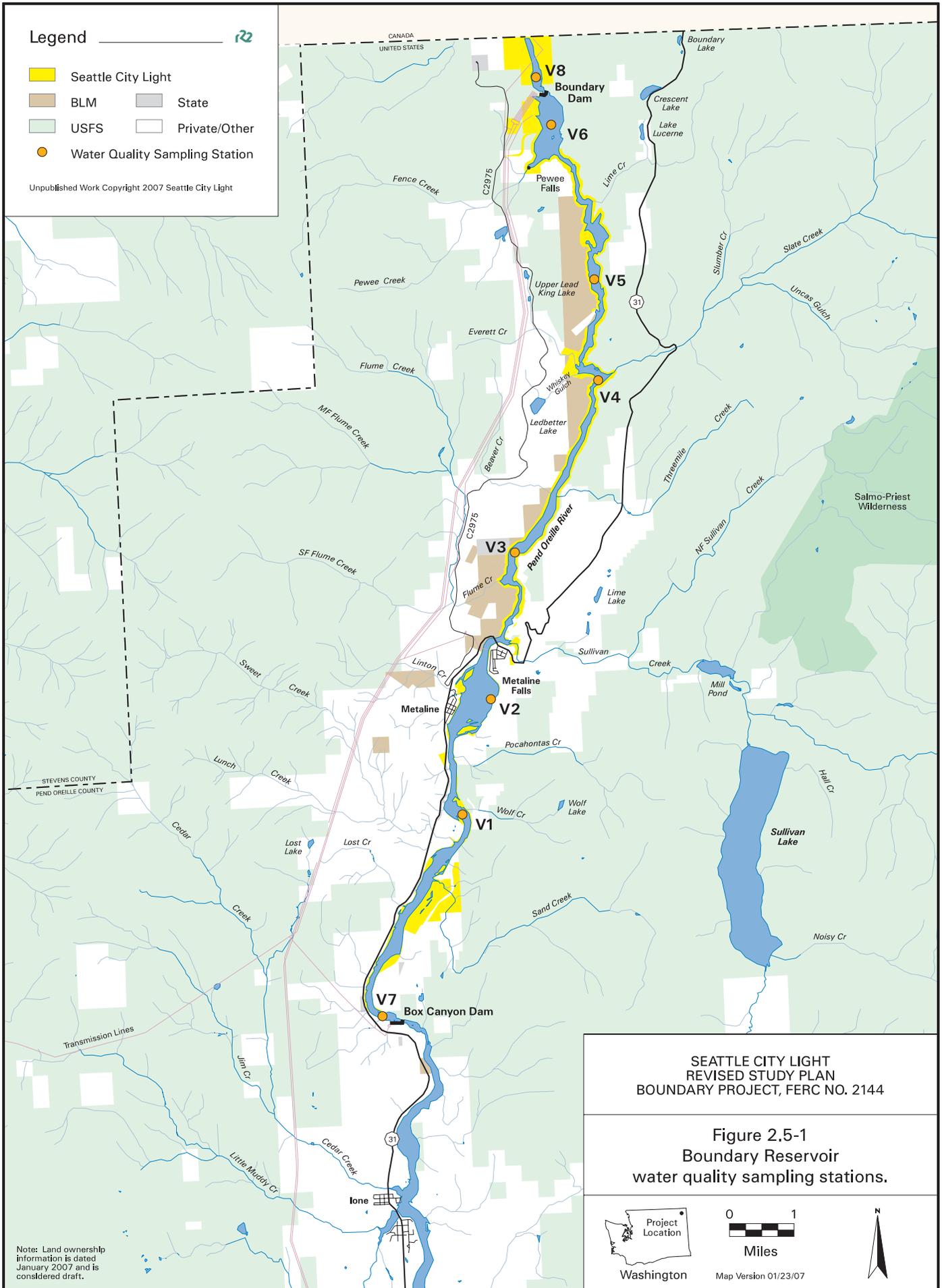
The proposed sampling stations, *in situ* data collection, and laboratory analyses are described in Table 2.5-1 and shown in Figure 2.5-1. The sampling stations were chosen to overlap with those used in the 2004, 2005, and 2006 SCL studies. During these studies, water quality was monitored at six stations within the reservoir that 1) characterized the longitudinal profile of water quality constituents in Boundary Reservoir, 2) represented important sites for assessing water temperatures in the mainstem river, 3) provided an even distribution of sites, and 4) addressed considerations of potential vandalism and security of equipment (Taylor Associates 2006). For this water quality study, two additional sites were added to represent water quality just downstream of Box Canyon Dam, and just downstream of Boundary Dam.

Legend



- Seattle City Light
- BLM
- USFS
- State
- Private/Other
- Water Quality Sampling Station

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Figure 2.5-1
Boundary Reservoir
water quality sampling stations.



Washington



Miles



Map Version 01/23/07

Note: Land ownership information is dated January 2007 and is considered draft.

Table 2.5-1. Planned sampling stations and water quality data collection¹.

Sample station	Location description	In-situ data collected	Laboratory analysis conducted
Box Canyon Tailrace (V7)	In Boundary Reservoir just downstream of Box Canyon Dam	Temperature, pH, DO, conductivity, Secchi	Chlorophyll <i>a</i> , nutrients, zooplankton ⁽¹⁾ , hardness
Wolf Creek (V1)	POR adjacent to Wolf Creek inlet (Upstream of Metaline Falls)	Temperature, pH, DO, conductivity, Secchi depth, turbidity	Chlorophyll <i>a</i> , nutrients, zooplankton, hardness
Metaline Old (V2)	Old channel of the POR across from the city of Metaline (Upstream of Metaline Falls)	Temperature, pH, DO, conductivity, Secchi depth	Chlorophyll <i>a</i> , nutrients, hardness
Pend Oreille Mine (V3)	Downstream of Pend Oreille Mine (Downstream of Metaline Falls)	Temperature, pH, DO, conductivity, Secchi depth, turbidity	Chlorophyll <i>a</i> , nutrients, hardness
Slate Creek (V4)	Downstream of Slate Creek across from campsite on left bank (Downstream of Metaline Falls)	Temperature, pH, DO, conductivity, Secchi depth	Chlorophyll <i>a</i> , nutrients, zooplankton, hardness
Everett Creek Island (V5)	Upstream of Everett Creek Island (Downstream of Metaline Falls)	Temperature, pH, DO, conductivity, Secchi depth	Chlorophyll <i>a</i> , nutrients, hardness
Boundary Reservoir Forebay (V6)	Boundary Forebay	Temperature, pH, DO, conductivity, Secchi depth, turbidity	Chlorophyll <i>a</i> , nutrients, zooplankton, hardness
Boundary Tailrace (V8)	Downstream of Boundary Dam	Temperature, pH, DO, conductivity, Secchi depth, turbidity	Chlorophyll <i>a</i> , nutrients, zooplankton ⁽¹⁾ , hardness

⁽¹⁾ Two zooplankton tows will be taken mid-channel at tailrace sites.

Brief descriptions of sampling analyses and methods are outlined in Table 2.5-2. Field sampling and measurement protocols will follow established Ecology and EPA guidelines. All laboratory analyses will be conducted by an Ecology- and EPA-accredited laboratory and analyzed in triplicate. Zooplankton and turbidity measurements will be collected at only five of eight² proposed sampling stations, because fewer samples are needed to characterize the system. Zooplankton data will be collected in both the pelagic and littoral regions of the reservoir for use in the productivity analysis being conducted as part of Fish and Aquatic resource studies. In the pelagic region, two full vertical tows will be made from 1 meter above the bottom to the surface using a Wisconsin-style plankton net and bucket. For the littoral region, the water column within the euphotic zone will be sampled following standard methods for shallow areas, with and without vegetation. Zooplankton will be collected within the water column and not on macrophytes themselves.³ The planned schedule for zooplankton sampling is outlined in Table 2.5-3.

¹ Table 2.5.1 has been modified from the PSP to be consistent with Study No. 11, Productivity Assessment.

² This modification from the PSP was done to be consistent with Table 2.5.1 and the study plan outline presented to relicensing participants at the June 27, 2006 Fish and Aquatics Workgroup meeting.

³ The PSP inadvertently included a statement that zooplankton would be sampled on macrophytes as part of Fish and Aquatics studies. Sampling of periphyton and benthic macroinvertebrates will be conducted as part of the Mainstem

Table 2.5-2. Planned sampling parameters and collection methods.

Parameter	Number of analyses required	Method
Temperature	Vertical profile	No fewer than 10 measurements at evenly spaced depth intervals
Dissolved Oxygen (DO)	Vertical profile	No fewer than 10 measurements at evenly spaced depth intervals
pH	Vertical profile	No fewer than 10 measurements at evenly spaced depth intervals
Conductivity	Vertical profile	No fewer than 10 measurements at evenly spaced depth intervals
Secchi Depth	1 per station	Average of two readings ¹
Chlorophyll <i>a</i>	2 per station An additional 1 per zooplankton station	One at surface and one at approximately 15 feet One in the littoral region
Nutrients (Kjeldahl nitrogen, , total phosphorus, orthophosphorus)	1 per station	Surface sample
Hardness	1 per station	Bottom sample
Turbidity	2 per station	One surface sample in the littoral region and one in the pelagic region
Zooplankton	4 tows per station	2 tows in the littoral region and 2 tows in the pelagic region; except only two tows will be taken mid-channel at tailrace sites.

Note:

1 To maintain consistency throughout the monitoring program, specific guidelines for Secchi depth measurements will be developed. These guidelines will be included in the Quality Assurance Project Plan (QAPP) and will outline such conditions as which side of the boat the measurement should be collected on given the angle of the sun or the use of sunglasses, etc.

Table 2.5-3. Planned zooplankton sampling frequency.⁴

	2007								2008		
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Species/Seasonality/Size/Distribution (2 tows in littoral zone; 2 tows in deep water zone; except only 2 tows will be taken mid-channel at tailrace sites)											
Box Canyon Tailrace (V7)	X	X	X	X	X		X		X		X
Wolf Creek (V1)	X	X	X	X	X		X		X		X
Slate Creek (V4)	X	X	X	X	X		X		X		X
Everett Creek Island (V5)	X	X	X	X	X		X		X		X
Boundary Forebay (V6)	X	X	X	X	X		X		X		X
Boundary Tailrace (V8)	X	X	X	X	X		X		X		X
Diurnal Drift (Fixed nets; 20 minutes sets; every 2 hours for 24 hours)											
Box Canyon Tailrace (7)	X			X					X		
Boundary Tailrace (V8)	X			X					X		

Aquatic Habitat Model (Study Plan No. 7) and Productivity Assessment (Study Plan No. 11). However, no sampling of zooplankton on macrophytes is proposed.

⁴ Table 2.5-3 has been added to the plan to help clarify between the two types of zooplankton sampling proposed.

All water column zooplankton samples collected in the study will be sent to a qualified taxonomic laboratory for identification, enumeration, and length measurements. Zooplankton will be identified to at least the genus level and, if possible, to the species level. Resulting data will allow for the calculation of density (organisms per liter) and biomass. Biomass estimates will be made using length-weight regressions, based on information from the literature (Bottrell et al. 1976; Downing and Rigler 1984; Dumont et al. 1975).

Seasonality and Drift of Zooplankton

The second component of the study includes collection of seasonal zooplankton drift data below Box Canyon and Boundary dams to quantify the movement of zooplankton into and out of Boundary Reservoir. Downstream of Boundary Dam, samples will be collected before, during, and after Project startup to quantify the impact of Project operations on zooplankton movement. Data will be collected at similar times downstream of Box Canyon Dam. Data will be collected in the summer, winter, and spring and will coincide with other water quality monitoring. Summer sampling will be conducted in either July or August, winter sampling in January, and spring sampling in May. The sample timing may be adjusted during implementation by the Technical Consultant because of flow levels or other factors affecting the ability to sample during the proposed months. The evaluation of zooplankton drift is intended to complement the monthly zooplankton data collection described in the previous section. Table 2.5-3 provides a summary of the two forms of proposed zooplankton sampling.

A pair of drift nets or plankton nets with 80–153 μm mesh nets will be set below each dam. If possible, nets will be deployed along the shoreline in flowing water at depths of 1–2 m. If no suitable shoreline area exists for deploying nets in this fashion, the nets will be deployed at depths of 1–2 m from a boat in the center of the channel. During each sampling month, nets will be set for 20-minute periods every 2 hours over a 24-hour period. Set times and frequencies will be adjusted as necessary based on the extent to which nets become clogged with drifting debris. Specifics regarding the locations and methods for zooplankton drift sampling will be refined by the technical consultant conducting this study and will be sufficient to meet the requirements of the study given the environmental conditions and restrictions. Laboratory analysis of zooplankton samples will be conducted as described in the previous section.

Quality assurance and control (QA/QC) measures will be observed to ensure that the following objectives are met: data are consistent, correct, and complete, with no errors or omissions; QC sample results have been reviewed and are included; established criteria for QC results were met; measurement quality objectives have been met, or data qualifiers are properly assigned where necessary; data specified in the sampling process design were obtained; and methods and protocols specified in the QAPP were followed.

2.6. Work Products

Four work products are required for completion of the Water Quality Constituent and Productivity Monitoring Study:

- *Quality Assurance Project Plan* — The first work product is a Quality Assurance Project Plan (QAPP), which will be finalized before field sampling begins. The QAPP must address elements specified by Ecology guidelines including the following items:
 1. Title Page with Approvals
 2. Table of Contents with Distribution List
 3. Background
 4. Project Description
 5. Organization and schedule
 6. Quality Objectives
 7. Sampling Process Design
 8. Sampling Procedures
 9. Measurement Procedures
 10. Quality Control
 11. Data Management Procedures
 12. Audits and Reports
 13. Data Verification and Validation
 14. Data Quality Assessment
- *Productivity data compilation* — The second work product is a compilation of productivity data for the reservoir productivity analysis being conducted under the Fish and Aquatic resources study program. Data will be submitted in an electronic format so the information can be easily incorporated into the reservoir productivity analysis. Frequency and format of submittals will be coordinated between the Fish and Aquatics and Water Quality technical consultants.
- *Interim study report* — An interim study report will contain monitoring methods, deviations from the QAPP, a brief summary of 2007 monitoring to date and laboratory data received, and recommendations for any changes to subsequent monitoring.
- *Final study report* — A final study report will describe the monitoring methods, results of the 2007 and 2008 monitoring, and conclusions of the Boundary Project area water quality constituent and productivity monitoring.

2.7. Consistency with Generally Accepted Scientific Practice

The methods described herein have been developed in consultation with the resource agencies, tribes, and other relicensing participants. The study approach and methods are consistent with Ecology's Water Quality Certification for Existing Hydropower Dams: Preliminary Guidance Manual (September 2004). The QAPP will be consistent with State and federal guidelines including EPA's Quality System for Environmental Data and Technology and Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. The laboratory selected to analyze water quality samples will be fully Ecology- and EPA- certified to conduct the analyses included in this study.

2.8. Consultation with Agencies, Tribes, and Other Stakeholders

As indicated above, SCL met with Ecology in 2005 to identify issues to be addressed as part of the 401 certification process. Input regarding water quality sampling was also provided by relicensing participants during workshops and workgroup meetings. Workshops were held in Spokane, Washington, on November 30, 2005, and February 16, 2006. Workgroup meetings were held in Spokane on May 22, 2006, and in Metaline Falls on June 29, 2006. During the May 22 workgroup meeting, an outline for this study plan was presented and comments were provided by relicensing participants. During the June workgroup meeting, the draft study plan was presented and relicensing participants provided comments. Relicensing participants attending the workgroup meetings included Ecology, the USGS, Confederated Tribes of the Colville Reservation, Kalispel Tribe of Indians, Columbia River Intertribal Fisheries Commission, BC Hydro, Pend Oreille County Public Utility District, Columbia Power Corporation, Environment Canada, Ponderay Newsprint, and Teck Cominco. Comments provided by relicensing participants on draft versions of this study plan are summarized in the PSP Attachment 3-5 (SCL 2006b) and can also be found in meeting summaries for these workgroup meetings and workshops (available on SCL's relicensing website [<http://www.seattle.gov/light/news/issues/bndryRelic/>]).

In its PAD/Scoping comments submitted to FERC (Ecology 2006), Ecology noted that, "The first paragraph of the draft [Water Quality Constituent and Productivity Monitoring] study plan stated that water quality issues, and non-compliance with state water quality standards, in the Boundary Reservoir appear to be limited to pH, total dissolved gas and possibly toxics. Temperature should be added to this list." The first paragraph of this study plan was revised in accordance with Ecology's request. The proposed study plan was included in the PSP that was filed with FERC on October 16, 2006.

Since filing the PSP, SCL has continued to work with relicensing participants on its proposed study plans. In response to comments made during the November 15, 2006 study plan meeting, comments provided during an October 10, 2006 meeting with staff from SCL, WDFW, and the Kalispel Tribe, and comments filed with FERC by the USFS (2007) and WDFW (2007), SCL has further modified the plan for the Water Quality Constituent and Productivity Monitoring. (SCL's responses to comments are summarized in Attachment 3 and consultation documentation is included in Attachment 4 of this RSP.) Modifications included adding clarification and additional detail to address relicensing participants' comments. Where differences remain between study requests and study elements, SCL has so noted in Attachment 3 of this RSP. Additional details regarding the sampling plan will be developed in early 2007 when the Technical Consultant finalizes the study implementation details in coordination with SCL and relicensing participants (Attachment 1, section 2.2 of this RSP).

2.9. Schedule

The schedule for completing this study is provided in Table 2.9-1.

Table 2.9-1. Study schedule, Water Quality Constituent and Productivity Monitoring.

Phase	Target Date
QAPP	March 31, 2007
Field Collection	May 2007 – March 2008
Prepare interim study report (first-year results)	November–December 2007
Distribute interim study report	January 2008
Meet with relicensing participants to review first year efforts and results and discuss plans for any second year efforts	February 2008
Include interim study report in Initial Study Report (ISR) filed with FERC	March 2008
Hold ISR meeting and file meeting summary with FERC	March 2008
Data review and report preparation	May–June 2008
Prepare “draft” final study report	October–November 2008
Distribute “draft” final study report for relicensing participant review	December 2008
Meet with relicensing participants to review study efforts and results and “cross-over” study results	January 2009
Include final study report in Updated Study Report (USR) filed with FERC	March 2009
Hold USR meeting and file meeting summary with FERC	March 2009

2.10. Progress Reports, Information Sharing, and Technical Review

Both the interim status report and final study report will be available to relicensing participants. Prior to release of the Initial and Updated Study Reports (which will include the results of this study), SCL will meet with relicensing participants to discuss the study results, as described in Attachment 1, section 2.3 of this RSP. The final study report will contain an appendix of the raw water quality data, which will also be available in digital format.

2.11. Anticipated Level of Effort and Cost

Based on a cursory review of study needs, the anticipated cost for this study is \$215,000. Approximately \$140,000 will be required in 2007 and \$75,000 in 2008. This estimated cost assumes all laboratory analyses will be conducted in triplicate and that field costs can be minimized by conducting data collection in conjunction with the Evaluation of the Relationship of pH and DO to Macrophytes in Boundary Reservoir water quality study (described in Study No. 6).

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