Wallowa Falls Hydroelectric Project

FERC Project No. P-308

Revised Study Plans – Water Resources

December 2011

Prepared by
CH2M Hill for:

PacifiCorp Energy
Hydro Resources
825 NE Multnomah, Suite 1500
Portland, OR 97232

For Public Review

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1.0 INTRODUCTION

This document provides the proposed Water Resources Study Plan for PacifiCorp's Wallowa Falls Hydroelectric Project (Project). This Study Plan describes the purpose, objectives, approach, and methods for the evaluation of hydrologic and water quality resources in the Project area. The Study Plan is structured to provide information and explanation of the planned study according to Federal Energy Regulatory Commission (FERC) guidelines for study plans in connection with the Integrated Licensing Process (ILP) for hydroelectric projects (18 CFR 5.11).

The hydrology information to be obtained in this study will include collection of flow data to support PacifiCorp's license application to FERC, including: (1) a quantification of available flows for Project operations; (2) ranges in flows and monthly flow duration curves; and (3) flow information to support analysis of instream flow needs for water quality and aquatic biota (18 CFR 5.18(b)).

The water quality information to be obtained in this study will include collection of data as required by FERC regulations (18 CFR 5.18(b)) to support Project relicensing documentation. This required water quality information will be used to: (1) describe existing water quality conditions in the Project area; and (2) assess Project effects on water quality. The water quality information also will support certification that FERC will require from the Oregon Department of Environmental Quality (DEQ) that the Project meets applicable state water quality requirements pursuant to Section 401 of the Clean Water Act (hereafter referred to as "401 Certification").

2.0 STUDY DESCRIPTION AND OBJECTIVES

Per 18 CFR §5.11(d)(1), this section describes the goal and objectives of the study and the information to be obtained. The goal of the study is to develop hydrology and water quality information to support: (1) a new FERC license application for continued future operation of the Project; and (2) 401 Certification from DEQ that the Project meets applicable state water quality requirements.

The study has two principal objectives:

1. <u>Characterize and assess hydrology in the Project vicinity</u>. This hydrologic information is needed to: (i) characterize flow conditions in the Project area and flow availability for Project operations; (ii) evaluate potential Project effects on flows and water quality (as related to flow); and (iii) support evaluation of flow effects and instream flow needs pertinent to aquatic biota (e.g., bull trout).

2. <u>Monitor and evaluate key water quality parameters in the Project vicinity</u>. The study will monitor and evaluate key water quality parameters that may be affected by Project facilities and operations, including those for which DEQ has established numeric or narrative water quality criteria and that are important to inform evaluation of water quality conditions for aquatic species (e.g., bull trout).

3.0 RESOURCE MANAGEMENT GOALS

Per 18 CFR §5.11(d)(2), this section addresses resource management goals of the agencies with jurisdiction over the hydrologic and water quality resources to be studied. Before issuing a new license for the Project, FERC will require 401 Certification from DEQ that certifies the Project meets applicable state water quality standards or criteria. The standards and criteria applicable to the Project are defined under Oregon Administrative Rules (OAR) Division 41 ("Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon") administered by DEQ. The overall goal of the state's water quality standards and criteria is to prevent the degradation of waters of the state and to maintain existing and designated uses. In conducting the 401 Certification process for the Project, it is anticipated that DEQ also will coordinate with the Oregon Water Resources Department (OWRD) to ensure adherence to the state's hydroelectric water rights program, and the Oregon Department of Fish and Wildlife (ODFW) related to recommended instream flow needs for protection of aquatic biota (under OAR 340-048).

4.0 EXISTING INFORMATION

Per 18 CFR §5.11(d)(3), this section describes existing hydrology and water quality information pertinent to the Project, and the need for additional information. Existing hydrology and water quality information pertinent to the Project is provided in the Pre-Application Document (PAD) (PacifiCorp 2011).

4.1 Hydrology Information Pertinent to the Project

The Project facilities are located along and adjacent to the East Fork and West Fork of the Wallowa River upstream of Wallowa Lake, near the town of Joseph, Oregon. The East Fork and West Fork of the Wallowa River are relatively pristine streams that originate in the Eagle Cap Wilderness Area in the Wallowa Mountains. The East Fork and West Fork join about 0.5 miles below the Project powerhouse tailrace, and the Wallowa River continues to flow north about 0.6 miles into Wallowa Lake.

Elevations in the area range from 4,440 feet at Wallowa Lake to over 8,000 feet at the headwaters in the wilderness area. Temperature and precipitation vary considerably with elevation. Average annual precipitation increases from 22 inches in the town of Joseph (near the outlet of Wallowa Lake) to more than 60 inches in the mountainous headwaters areas. On average, precipitation increases approximately 5 inches with each 1,000-foot rise in elevation (Nowak and Kuchenbecker 2004). Precipitation occurs in the mountains throughout the year but falls primarily as winter snow. Generally, peak snow occurs in the area around March and April.

The East Fork and West Fork of the Wallowa River are snowmelt runoff streams. As such, snow acts as an important flow regulator or storage mechanism, holding a significant proportion of the precipitation in the area during the winter and releasing it later in the year as it melts. Peak runoff occurs in later spring to early summer, generally from May through mid-July, from melting snowpack. By late July, little of the snow is left in the Wallowa Mountains. Runoff recedes to low flows by late summer, usually August and September. Flows can again increase in fall in response to autumn rains, but lower flows generally persist from late fall through winter due to freezing conditions in the contributing high-elevation watershed areas, which result in little or no direct runoff during this time.

As explained in the PAD (PacifiCorp 2011), available flow information for the Project area is largely confined to USGS streamflow data gathered data at two locations in the Project vicinity over a 58-year period from October 1924 through September 1983. The two historic USGS gages were located in the Project tailrace (USGS Station 13324500) and in the East Fork one quarter mile upstream of the confluence with the West Fork (USGS Station 13325000). The USGS also developed flow data for a third "reporting station" (USGS Station 13325001) that is a summation of data collected at the two gage sites. The data for the reporting station (USGS Station 13325001) represents the best data available characterizing the hydrology of the East Fork in the Project vicinity.

Based on the previous 58-year period of record, average monthly minimum flows in the East Fork ranged from 7.7 cubic feet-per-second (cfs) in March to 25.2 cfs in June, and average monthly maximum flows ranged from 14.6 in March to 142.2 cfs in June. Average mean monthly flows in the East Fork ranged from 11 cfs in February and March to 61 cfs in June. During the period of record, monthly flows met or exceeded 10 cfs 90 percent of the time, 14 cfs 50 percent of the time, and 45 cfs 10 percent of the time.

4.2 Water Quality Information Pertinent to the Project

Overall water quality in the Wallowa River watershed is considered excellent, due to the relatively pristine location and physical characteristics of the watershed areas, most of which lies within the Eagle Cap Wilderness Area (Nowak and Kuchenbecker 2004).

Because the East Fork and West Fork are supplied by direct snowmelt runoff or groundwater baseflow, they are consistently relatively cold throughout the year. Available water temperature data for the Project area shows that the seven-day average of the maximum daily temperature (7-DAD Max) remains below about 8.0 degrees Celsius (ºC) through June and after about mid-September (PacifiCorp 2011). Even during the summer months of July and August, when air temperature and solar radiation are highest, available data shows that 7-DAD Max water temperatures remain below about 12.0 ºC, which is equivalent to the state temperature criteria for bull trout spawning and juvenile rearing use (OAR 340-041-0028(4)(f).

Other water quality data for the Project area is sparse. Dissolved oxygen sampling previously conducted by PacifiCorp showed dissolved oxygen concentrations of 8.9 to 9.1 milligrams per liter (mg/L) in samples taken in mid-summer in the East Fork upstream, within, and downstream of the Project forebay (Eddy 1985). These values indicate that dissolved oxygen was near 100 percent saturation, as expected, for the water temperature and elevation of sampling. Dissolved oxygen at saturation is expected given the turbulent and pristine nature of the streams in the area.

5.0 NEXUS TO PROJECT

Per 18 CFR §5.11(d)(4), this section describes the nexus between Project operations and effects on hydrology and water quality. Relative to hydrology, the primary Project nexus is the diversions of portions of the flow from the East Fork (and lesser diversions from Royal Purple Creek) for use at the Project powerhouse. As explained in the PAD (PacifiCorp 2011), the Project is operated in run-of-the-river mode with no peaking or flood control capability. Because of the diversion of flows to the powerhouse, Project operation causes a reduction in downstream in-channel flows in the East Fork below the East Fork diversion dam. This portion of the East Fork is referred to as the “bypassed reach”.

During standard operation (which is done in a remotely-controlled automated mode), the minimum hydraulic capacity of the powerhouse is approximately 3 cfs and the maximum hydraulic capacity is 16 cfs. Thus, the total amount of flow diverted to the Project powerhouse ranges from 3 to 16 cfs. Recent records of powerhouse (turbine) discharge indicate that average monthly discharge (and, hence, amount diverted) ranged from a low of 9.6 cfs in February to a high of about 16 cfs in June.

The current FERC license for the Project requires that flow releases are provided from the East Fork diversion dam to maintain a continuous minimum instream flow in the bypassed reach of the East Fork. The required minimum instream flow release is in the amount of 0.5 cfs or the natural inflow to the reservoir, whichever is less, as measured immediately downstream from the diversion dam. However, instream flows in the bypassed reach typically exceed the required minimum instream flow release for three reasons. First, the required minimum flow is released through a fixed pipe at the diversion dam, and measurements indicate that the pipe releases approximately 0.8 cfs, 0.3 cfs more than the required minimum flow. Second, natural accretion of flow occurs in the bypassed reach. Information on the quantity of this accretion is limited to only a few measurements by PacifiCorp personnel during relatively low flow conditions, indicating accretion in the bypassed reach on the order of a 1 to 2 cfs. A larger amount of accretion in the bypassed reach possibly occurs seasonally, such as during snowmelt runoff conditions. Third, during higher-flow times of the year (e.g., the snowmelt runoff period), flows arriving at the diversion dam from upstream are likely in excess of 16 cfs, which is the maximum hydraulic capacity of (and hence diversion to) the powerhouse. At these times, all flows in excess of 16 cfs remain within the bypassed reach. This can occur in many months, but is particularly prevalent in the months of May, June, and July.

Relative to water quality, the primary Project nexus also results from the diversions of portions of the flow from the East Fork (and to a lesser extent Royal Purple Creek) for use at the Project powerhouse. Project facilities and operations do not cause any direct discharge or load of water quality-related constituents to Project waters. However, the diversion of flow has the potential to affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypass reach), which may in turn affect water quality parameters influenced by such conditions (such as, water temperature).

Also, under current operations, PacifiCorp flushes the forebay behind the East Fork diversion dam to reduce sediment build-up on an as-needed basis. The current FERC license restricts forebay flushing to the period of May 1 through August 30 of each year for the protection of kokanee eggs and sac fry in the gravel areas upstream of Wallowa Lake. Such flushing has the ability to increase suspended sediments and turbidity downstream of the diversion dam.

The nexus of the Project facilities and operations to key water quality parameters addressed by state standards and criteria (OAR 340-041) are summarized in Table 5.0-1. On the basis of Project nexus and the rationale as described in Table 5.0-1, this Study Plan specifically focuses on the key water quality parameters of water temperature, dissolved oxygen, turbidity, and total dissolved gas (TDG). Further rationale and discussion of the focus on these particular parameters for this study are provided in the following section on Study Approach.

Table 5.0-1 Rationale for Sampling Planned in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Planned?	Rationale	Applicable Standard
Numeric Criteria			
Water Temperature	Yes	Project facilities and operations do not cause any direct thermal discharge or load to Project waters. Project operations can affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypass reach). Such effects have the potential to affect water temperature by increasing the amount of solar radiation entering the water. Analysis of these potential effects is warranted as water temperature is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0028
Dissolved Oxygen	Yes	Project facilities and operations do not contribute any oxygen-demanding substances in Project waters. Project operations can affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypass reach). Such effects are unlikely to affect DO, although verification is warranted as DO is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0016(1)
Turbidity	Yes	Increases in turbidity are possible when water is spilled from the diversion dams due to maintenance flushing of the forebay. Turbidity will be monitored during such maintenance flushing.	OAR 340-041-0036
Total Dissolved Gas	Yes	Total dissolved gas (TDG) supersaturation can occur at hydropower facilities when large volumes of water are spilled from dams and entrain significant volumes of atmospheric gases. TDG supersaturation typically occurs only at larger mainstem dams, where relatively deep reservoirs or non-turbulent river reaches offer less-effective gas dissipation than shallow, more turbulent river reaches that facilitate degassing. Therefore, TDG supersaturation is not expected for this Project, although verification is warranted as TDG is an important parameter for supporting cold-water biota (e.g., bull trout) in Project waters.	OAR 340-041-0031(2)
Nuisance Phytoplankton Growth	No	Project facilities and operations do not contribute to phytoplankton growth in Project waters. There are no Project-related discharges of nutrients or other conditions that would contribute to primary production.	OAR 340-041-0019

Table 5.0-1 Rationale for Sampling Planned in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Planned?	Rationale	Applicable Standard
pH (Hydrogen Ion Concentration)	No	There are no Project-related discharges of nutrients or other conditions that contribute to primary production that could affect pH. Project facilities and operations do use or discharge any other substances to Project waters that could affect buffering capacity and pH.	OAR 340-041-0156(1)
Total Dissolved Solids	No	Project facilities and operations do not discharge substances to Project waters that could affect total dissolved solids. The Project does not engage in irrigation or water reuse that could act to increase total dissolved solids.	OAR 340-041-0156(2)
Toxic Substances	No	Project facilities and operations do not discharge any potentially-toxic substances to Project waters.	OAR 340-041-0033
Bacteria	No	Project facilities and operations do not contribute to bacteria levels in Project waters. There are no Project-related discharges of raw or treated sewage or animal wastes into Project waters. Composting or vault type toilets are used at Project facilities.	OAR 340-041-0009
Narrative Criteria			
Biocriteria	Yes	This criterion clarifies that waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities. Compliance with this criterion will be determined based on data obtained from water temperature, DO, and other monitoring as described above, as well as fisheries and macroinvertebrate data collected as part of the Aquatics Study Plan[1].	OAR 340-041-0011
Aesthetic Conditions	No	Project facilities and operations do not create or cause any known aesthetic conditions offensive to the human senses of sight, taste, smell, or touch. No sampling is necessary or proposed to address this criterion. Any potential for Project effects on aesthetic conditions would be related to turbidity, which can be inferred from data obtained from turbidity monitoring as described above. Other aspects of aesthetics and visual character related to Project facilities will be assessed under the Aesthetic and Visual Resources Study Plan[2].	OAR 340-041-0007(14)

[1] See the Aquatics Study Plan for details on the approach and methods to be used for fisheries and macroinvertebrate data collection.
[2] See the Aesthetic and Visual Resources Study Plan for details on the approach and methods to be used to evaluate Project effects on aesthetic resources.

Table 5.0-1 Rationale for Sampling Planned in this Study of Water Quality Parameters Addressed In Standards or Criteria Under Oregon Administrative Rules (OAR).

Parameter	Sampling Planned?	Rationale	Applicable Standard
Dissolved Gases	No	Project facilities and operations do not create or cause dissolved gases that produce objectionable odors or result in deleterious effects on designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0031(1)
Tastes or Odors	No	Project facilities and operations do not create or cause taste or odors issues affecting water potability or fish consumption. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(11)
Discoloration, Scum, Oily Sleek	No	Project facilities and operations do not create or cause objectionable discoloration, scum, oily sheens, or floating solids. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(13)
Bottom or Sludge Deposits	No	Project facilities and operations do not create or cause formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(12)
Development of Fungi	No	Project facilities and operations do not create or cause the development of fungi or other growths having deleterious effects on designated beneficial uses. No sampling is necessary or proposed to address this criterion.	OAR 340-041-0007(10)
Radioisotopes	No	No radioisotopes are being added to the water by the Project, and there are no known naturally-occurring problems with radioisotopes.	OAR 340-041-0007(15)

6.0 STUDY APPROACH

Per 18 CFR §5.11(b)(1) and §5.11(d)(5), this section describes the Study Area, the specific parameters that will be studied, the specific monitoring and sampling sites, and the timing and duration of sampling activities.

6.1 Study Area

The Study Area pertinent to the evaluation of hydrology and water quality includes the following waters:

1. East Fork Wallowa River and Royal Purple Creek inflows to Project diversions;
2. East Fork Wallowa River bypass reach;
3. Project tailrace; and
4. West Fork Wallowa River into which tailrace waters discharge.

6.2 Study Parameters

The study will assess five flow and water quality parameters at seven sampling sites in the vicinity of the Project over a one-year study period, with the possibility of additional sampling during a second year. During the first year of the study, five flow and water quality parameters at seven sampling sites in the Project vicinity will be monitored. PacifiCorp will summarize the data (in the initial study report) and discuss with interested stakeholders (at the initial study plan meeting) if certain parameters warrant additional monitoring during a second year. The decision to conduct further monitoring will be based on, but not limited to, meeting the state water quality standards (discussed below in section 7.0 Study Methodology), and atypical climate and hydrology conditions (e.g., wet year vs. dry year) that may have occurred during 2012. The five flow and water quality parameters and associated methods are summarized in Table 6.2-1. Specific monitoring and sampling sites in the Study Area are described further below in section 7.0 Study Methodology.

Table 6.2-1 Parameters and Sampling Techniques for the Proposed Study.

Parameters	Type	Sampling Technique
Flow	Continuous	Continuously record hourly values for one-year period using stage gaging (at 5 sites).
Water temperature	Continuous	Continuously record hourly values for one-year period using thermographs associated with flow dataloggers (at 4 flow gage sites).
Water temperature	Continuous	Continuously record hourly values for one-year period using thermographs (at 3 additional water temperature sites).
Dissolved oxygen	Continuous	Continuously record hourly values for three 72-hour periods in late August through October (at 3 sites).
Total dissolved gas	Discrete	Collect grab samples twice daily on two consecutive days per month for June-September period using a TDG probe in the Project tailrace.
Turbidity	Continuous	Continuously record hourly values for multi-day period that extends before, during, and after maintenance flushing using datasondes (at 3 sites).

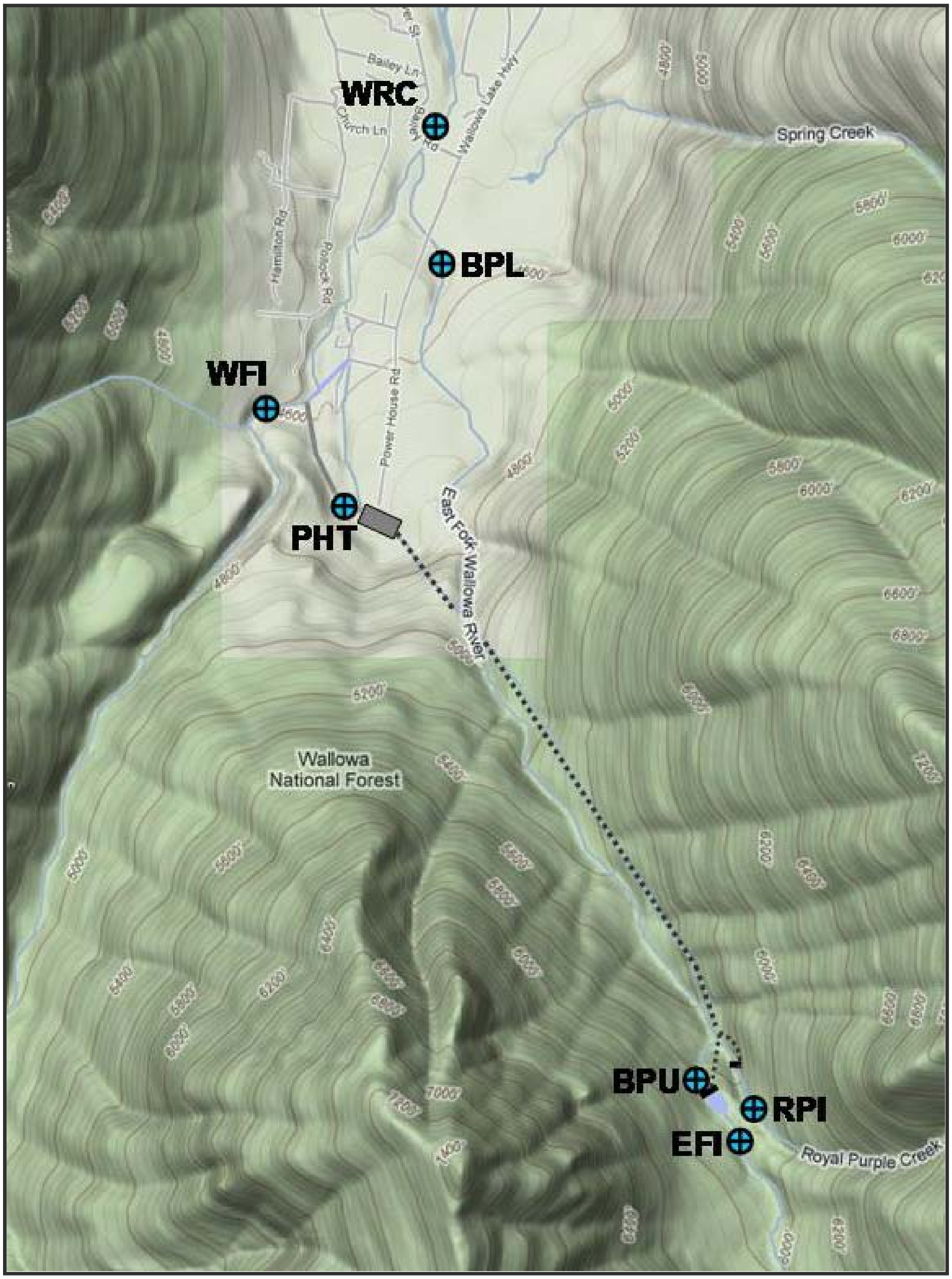
6.3 Study Sites

The study includes seven monitoring and sampling sites. The seven sites are summarized in Table 6.3-1, and Figure 6.3.1 shows the locations of the sites. The sampling sites are chosen for their ability to represent conditions within the Study Area (as defined above) and to assess potential effects of Project facilities and operations on water quality.

Table 6.3-1 List of Sample Sites (and Their Associated Codes) for the Study.

Sample Site	Associated Code
East Fork Wallowa River Inflow to Project Forebay	EFI
Royal Purple Creek Inflow to Project Diversion	RPI
East Fork Wallowa River Bypass Reach – Upper End	BPU
East Fork Wallowa River Bypass Reach – Lower End	BPL
Tailrace below Project Powerhouse	PHT
West Fork Wallowa River Upstream of Tailrace Discharge	WFI
Wallowa River Downstream of E.F. and W.F. Confluence	WRC

Figure 6.3.1. Locations of monitoring and sampling sites in the Study Area.



6.4 Sampling Timing and Duration

Sampling timing and duration will vary by parameter and sampling locations, as summarized in Table 6.4-1. They will be five types of sampling timing and duration:

1. Continuous (hourly) sampling throughout the year of flow and water temperature (at flow gaging sites)

2. Continuous (hourly) sampling throughout the year of water temperature (at additional water temperature sites)

3. Continuous (hourly) sampling for three 72-hour periods in late August through October for dissolved oxygen

4. Discrete (twice daily) sampling for two-day periods each month from June to September for TDG

5. Continuous (hourly) sampling for multi-day period during forebay maintenance (for turbidity)

Table 6.4-1 List of Parameters, Sampling Events, and Sites for the Wallowa Falls Water Quality Program.

Parameters	**Type**	**Sampling Events**							**Sites**						
		Seasonal: January	**Seasonal: April**	**Monthly: June**	**Seasonal: July**	**Monthly: August**	**Monthly: September**	**Seasonal: October**	**EFI**	**RPI**	**BPU**	**BPL**	**PHT**	**WFI**	**WRC**
Flow	Continuous	▬	▬	▬	▬	▬	▬	▬	●	●	●	●	●		
Water temperature	Continuous	▬	▬	▬	▬	▬	▬	▬	●	●	●	●	●	●	●
Dissolved oxygen	Continuous					–	–	–	●		●	●			
TDG	Discrete			–	–	–	–						●		
Turbidity	Continuous					–			●			●	●		

7.0 STUDY METHODOLOGY

Per 18 CFR §5.11(b)(1) and §5.11(d)(5), this section describes the proposed study methodology, including data collection and analysis techniques.

7.1 Hydrology

7.1.1 Flow Gaging

Flow gaging will be conducted at five sites, including sites EFI, RPI, BPU, BPL, and PHT as listed in Table 6.3-1 and shown in Figure 6.3.1. The EFI site represents the primary source of inflow to the Project. The RPI site is a secondary and relatively minor source of inflow to the Project. The BPU and BPL sites represent flows in the upper and lower ends of the Project bypass reach, respectively, where Project effects on flow are most prevalent due to diversions from the diversion dam to the powerhouse. The PHT site represents the discharge from the Project powerhouse.

Flow gaging will be conducted based on open-channel stage-discharge monitoring methods in which stage (that is, water level or water depth) in the channel at each site is continuously monitored. Stage data is subsequently converted to an estimate of corresponding streamflow based on relationships (or "ratings") between streamflow and stage that are developed for each site (e.g., Gordon et al. 2004, Rantz et al. 1982). Stage (i.e., water level) measurements will be recorded at hourly intervals over a one-year period at the four sites using an in-situ water level datalogger (e.g., Solinst Levelogger Gold), which includes a pressure transducer, temperature sensor, and internal datalogger.

To develop the stage-discharge ratings for each site, a series of at least three instantaneous flow measurements will be made at or near the gage locations. These measurements will be based on the area-velocity technique, volumetric measurements, or the tracer dilution method[3] (salt dilution gaging), as appropriate for specific conditions at each site (e.g., NNPSMP 2008, Gordon et al. 2004, Hudson and Fraser 2002, Rantz et al. 1982). High flows that cannot be directly measured by such techniques will be determined using the slope-area method (Dalrymple and Benson 1968) or other indirect methods (Buchanan and Somers 1969, Rantz and others 1982).

Initial instantaneous flow measurements will be made using the area-velocity technique or volumetric measurements. However, if these methods produce problematic results due to the relatively low volume of flow, the salt dilution gaging method will be considered. Salt dilution gaging in the East Fork bypass reach, if used, will be based on the methods of Moore (2004a, 2004b, 2005). These methods accurately measure flows in turbulent streams by using a tracer solution containing common table salt (sodium chloride, NaCl), which is injected at a point upstream of where streamflow estimates are desired. Streamflow estimates are made for selected downstream locations past a distance where complete mixing of the injection solution has occurred, which is approximately a distance down the channel equal to about 10 average channel widths (e.g., within about 100 ft in the East Fork bypass reach). The streamflow estimates are

[3] If used, the tracer dilution method will adhere to specifications and procedures as required by applicable regulatory agencies.

computed by measuring the relative dilution in salinity (or conductivity) concentrations in the stream as compared to the initial concentration and rate of the injection solution.

Based on methodology details presented in Moore (2004a, 2004b, 2005), it is estimated that the "injection" would be done instantaneously by pouring 1 to 5 liters (amount depending on flow level in stream) of the tracer solution at the upstream "injection point" location. Depending on the quality of data readings collected downstream, it is possible that a second (and perhaps a third) injection "replicate" would be done, spaced approximately one hour apart. Concentrations of NaCl would be 50 mg/L or less at fully-mixed downstream locations in the East Fork bypass reach (based on an assumed 15 percent NaCl tracer injection solution as recommended by Moore [2005]). These concentrations of NaCl are far below the levels at which effects on aquatic biota have been observed and documented (Moore 2004a, Weikel et al. 2005). Higher concentrations of NaCl would occur at the injection point and immediately downstream as mixing occurs. However, these higher concentrations are short-lived and transient. For example, salt solution tracer tests by Weikel et al. (2005) showed conductivity concentrations spiked to a maximum of near 3500 µS/cm (about equivalent to an NaCl concentration of 2300 mg/L) at the injection point, but reached a maximum of 106 µS/cm (an NaCl concentration of about 70 mg/L) at point 40 ft downstream and 57 µS/cm (an NaCl concentration of about 38 mg/L) at a point 100 ft downstream where complete mixing had been achieved. Conductivity returned to background levels within a few minutes after the injection of tracer had ceased and the tracer "cloud" had passed by the measurement points.

This information indicates that no effects on aquatic biota would be expected from salt dilution gaging in the East Fork bypass reach. Higher concentrations near the injection point would last for only a few minutes and quickly dissipate, and concentrations at downstream mixed locations would also be short-lived and reach only modest NaCl concentrations of 50 mg/L or less – far below levels that would have effects on aquatic biota as documented in the research literature (Moore 2003a, Weikel et al. 2005).

7.1.2 Additional Flow Estimates

Continuous flow gaging at the RPI site is proposed (as discussed in section 7.1.1 above). However, accurate and reliable flow gaging at the RPI site may prove infeasible due to constraints posed by the site's small channel and flow levels. Therefore, if gaging is infeasible, flows at the RPI site will be estimated using correlation to the EFI gage (or other gages in the area), or through hydrologic models such as HEC-HMS (USACE 2000) as discussed further below in the "Data Analysis Methods" section. To enhance the correlation, instantaneous flow measurements will be made at or near the RPI site, if possible, using the area-velocity technique, volumetric measurements, or the tracer dilution method, as appropriate (e.g., NNPSMP 2008, Gordon et al. 2004, Hudson and Fraser 2002, Rantz et al. 1982).

7.1.3 Hydrologic Data Analysis Methods

For the gaged sites EFI, RPI, BPU, BPL, and PHT, mean daily and mean monthly flows will be calculated from collected streamflow data values. For site RPI, if gaging is infeasible (as discussed in section 7.1.2 above), daily and monthly flows will be synthesized using data from gaged site EFI based on regression and/or drainage area adjustment techniques (e.g., Sanborn and Bledsoe 2006, Gordon et al. 2004, Troendle 1985).

Summary tables of the flow measurement data will be produced, and will include sample dates, times, locations, and results. Mean daily and mean monthly flows, and lowest and highest (peak) hourly flows for each site will be computed and tabulated. Mean daily flows for each site will be graphed for assessment and discussion of trends.

The record of mean daily flows for site EFI will be extended, if possible, to provide a longer hydrologic period of record using correlation to records of daily flows from similar USGS gages data elsewhere in the region, an approach known as a basin transfer method (e.g., Sanborn and Bledsoe 2006, Gordon et al. 2004, Troendle 1985, Riggs 1973, Riggs 1972). The extended record of mean daily flows for site EFI will be used to characterize the flows measured during this one-year study in context within the range of historic flow conditions.

The extended record of mean daily flows for site EFI also will be used to calculate flow duration statistics by month (e.g., Gordon et al. 2004, USGS 2001). Resulting monthly flow duration curves will relate flow values to the percent of time those values have been met or exceeded, which are useful for assessing flow availability for Project generation and instream flows.

7.2 Water Quality

7.2.1 Water Temperature

Water temperature will be monitored at seven sites, including sites EFI, RPI, BPU, BPL, PHT, WFI, and WRC as listed in Table 6.3-1 and shown in Figure 6.3.1. These seven sites will provide comprehensive spatial coverage of water temperature conditions upstream, within, and downstream of the Project area. Water temperature monitoring will occur year-round, with a focus on the period May to October, which is the portion of the year that includes: (1) presence of potentially-sensitive aquatic biota life stages (i.e., bull trout spawning and rearing; kokanee spawning); and (2) seasonally warmer meteorology and lower flow conditions, when potential Project effects on water temperatures, if present, are most likely to occur. While the period May to October is the focus, the water temperature collected for the other months will provide additional background on ambient water temperatures during colder meteorological conditions from November to April.

Sites EFI, RPI, and WFI are representative of inflow water temperature conditions to waters in the Project vicinity. These inflow sites will be used to help characterize natural thermal conditions in the watershed upstream of Project facilities. These sites also will be used to compare with downstream sites to assess potential water temperature changes as flows travel through the Project area. Sites BPU and BPL will be used to characterize water temperature in the East Fork bypassed reach and to assess potential effects on water temperatures in the reach due to diversion of flows from the reach to the powerhouse. Sites PHT will be used to characterize water temperature in flows discharged from the powerhouse and to assess potential effects due to diversion of flows through the powerhouse. Sites WRC will be used to characterize water temperature in the Wallowa River below the confluence of the East Fork and

West Fork and to assess potential effects on the Project, if any, on water temperatures in the Wallowa River downstream of the Project area.

Water temperature data will be collected using continuously-recording water temperature sensors (i.e., thermographs) installed at each site as indicated in Table 6.4-1. At sites EFI, RPI, BPU, BPL, and PHT, thermographs will consist of in-situ temperature sensors that are contained within water level dataloggers (e.g., Solinst Levelogger Gold) deployed at those sites for flow gaging (as described). At sites WFI and WRC, thermographs will consist of in-situ temperature dataloggers (e.g., Onset Tidbit UTBI-001)[4]. All temperature sensors will be deployed within the stream channel at each site at a point where complete mixing is expected. Temperature dataloggers will be programmed to record temperature on an hourly basis, and will be downloaded during scheduled sampling visits to the field as indicated in Table 6.4-1.

7.2.2 Dissolved Oxygen

Project effects on dissolved oxygen are unlikely for reasons as discussed in Table 5.0-1. However, dissolved oxygen monitoring will be conducted to assess conditions in the East Fork bypassed reach during three 72-hour periods to occur approximately every 3-4 weeks in late August through October. The East Fork bypassed reach is where Project operations have the most potential to affect physical flow conditions (e.g., flow quantity, depths, and velocities in the bypass reach). Dissolved oxygen monitoring data will be used to verify that changes in physical flow conditions do not affect dissolved oxygen saturation. The monitoring period will coincide with bull trout and kokanee spawning, and the associated increase in the dissolved oxygen standard set by the state of Oregon, as indicated in Table 7.2-1. The monitoring period also will include the period of the year when physical flow changes in the bypassed reach related to Project diversions are typically greatest.

Dissolved oxygen will be monitored at three sites, including sites EFI, BPU, and BPL as listed in Table 6.3-1 and shown in Figure 6.3.1. Sites BPU and BPL will be used to characterize dissolved oxygen conditions in the East Fork bypassed reach and to assess potential effects on dissolved oxygen in the reach due to diversion of flows from the reach to the powerhouse. Site EFI is representative of inflow dissolved oxygen conditions to the East Fork bypassed reach. This inflow site will be used to help characterize dissolved oxygen background conditions upstream of the bypassed reach.

Continuously-recording water quality datasondes will be deployed for dissolved oxygen at each site as indicated in Table 6.4-1. For dissolved oxygen data collection at sites EFI, BPU, and BPL, datasondes will include in-situ optical dissolved oxygen sensors (e.g., YSI Model 6920). These datasondes will be programmed to record sampled values on an hourly basis, and will be downloaded at the conclusion of scheduled sampling periods as indicated in Table 6.4-1.

7.2.3 Total Dissolved Gas (TDG)

Project effects on TDG are unlikely for reasons as discussed in Table 5.0-1. However, a monthly TDG sampling schedule will be implemented to assess TDG conditions downstream of the

[4] A separate in-situ temperature datalogger might also be used at site RPI if gaging proves infeasible at that site.

Project powerhouse for the period of June through September to verify that air entrainment from the powerhouse does not cause TDG supersaturation.

TDG will be monitored at PHT as listed in Table 6.3-1 and shown in Figure 6.3.1 to characterize TDG in waters discharging from the powerhouse. TDG data will be collected over a two-day period each month for June-September. Two discrete grab samples (morning and afternoon) will be collected and recorded each day at site PHT using a monitoring instrument equipped with an in-situ TDG pressure transducer (e.g., Hydrolab Model MS-5 or DS-5).

7.2.4 Turbidity

Turbidity monitoring will be conducted over multi-day period during maintenance of the forebay at the East Fork diversion dam (likely in July or August) when accumulated sediments in the forebay are released downstream. PacifiCorp may flush the Project forebay to reduce sediment build-up on an as-needed basis. Under the current license, forebay flushing is restricted to the period of May 1 through August 30 of each year for the protection of kokanee eggs and sac fry in the gravel areas upstream of Wallowa Lake.

Turbidity will be monitored at three sites, including sites EFI, BPL and PHT as listed in Table 6.3-1 and shown in Figure 6.3.1. Site EFI is representative of inflow turbidity conditions to the forebay. This inflow site will be used to help characterize background turbidity conditions upstream of the forebay. Site BPL will be used to characterize turbidity concentrations in the East Fork that results from waters flushed from the forebay during the maintenance event. Site PHT will be used to characterize turbidity concentrations in waters discharged from the powerhouse during the maintenance event.

Continuously-recording water quality datasondes will be deployed for turbidity data collection at sites as indicated in Table 6.4-1. For turbidity data collection at sites EFI, BPL, and PHT, datasondes will include in-situ optical turbidity sensors (e.g., YSI Model 6920). These datasondes will be programmed to record sampled values on an hourly basis, and will be downloaded at the conclusion of scheduled sampling periods as indicated in Table 6.4-1.

7.2.5 Water Quality Data Analysis Methods

Summary tables of the water quality data will be produced, and will include sample dates, times, locations, and results. Mean daily values, and lowest (minimum) and highest (maximum) daily values for each site will be computed and tabulated. Maximum, mean, and minimum daily values for each site will be graphed for assessment and discussion of trends. Key water quality statistics will be computed, including those listed in Table 7.2-1, and presented in tables and graphs for assessment and discussion of trends and compliance with standards.

Table 7.2-1 Assessment of Parameters Relative to Standards Compliance.

Parameters	Unit	Key Statistic	Associated Standard
Water temperature	°C	7-day average of the maximum daily water temperature (7-DAD Max)	Criteria in OAR 340-041-0028: May not exceed 12.0°C (53.6°F) in streams identified as having bull trout spawning and juvenile rearing use. "Natural Conditions Criteria" provides that where the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria (as above), the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable criteria[5]. When temperatures are colder than the biologically-based criteria (as above), waters may not be warmed by more than 0.3°C (0.5°F) above the colder water ambient temperature[6]. This provision applies to all sources taken together at the point of maximum impact. Also, exceedance of the biologically-based criteria (as above) is not considered a violation during conditions of highest air temperatures (the 90th percentile value of annual maximum seven-day average maximum air temperatures) or lowest flows (less than the 7Q10 low flow conditions). [7]
Dissolved oxygen	mg/L	Individual values as recorded	Criteria in OAR 340-041-0016: DO may not be less than 11.0 mg/l when trout spawning through fry emergence occurs. However, if the minimum intergravel DO is 8.0 mg/l or greater, then the DO criterion is 9.0 mg/l. Where ambient pressure and temperature conditions preclude attainment of the 11.0 mg/l or 9.0 mg/l criteria, DO levels must not be less than 95% saturation DO may not be less than 8.0 mg/l as an absolute minimum. Where ambient pressure and temperature conditions preclude attainment of the 8.0 mg/l, DO levels must not be less than 90% saturation.

[5] If necessary, the "natural thermal potential temperatures" will be determined using data from the EFI, RPI, and WFI sites (which represent inflow sites unaffected by the Project) adjusted as appropriate for downstream locations (e.g., using application of the Heat Source model).
[6] If necessary, the "colder water ambient temperature" will be determined using data from the EFI, RPI, and WFI sites (which represent inflow sites unaffected by the Project) adjusted as appropriate for downstream locations (e.g., using application of the Heat Source model).
[7] If necessary, these conditions will be determined based on locally-available air temperature and flow data.

Table 7.2-1 Assessment of Parameters Relative to Standards Compliance.

Parameters	Unit	Key Statistic	Associated Standard
TDG	percent saturation	Individual values as recorded	Criteria in OAR 340-041-0031: TDG may not exceed 110 percent of saturation (% saturation) relative to atmospheric pressure at the point of sample collection, except when stream flow exceeds the 10-year, 7-day average flood. However, TDG may not exceed 105 % saturation in waters of less than two feet in depth.
Turbidity	NTU[8]	Individual sample values as recorded	Criteria in OAR 340-041-0036: No more than a 10% cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity [9]. However, limited duration activities necessary to address an emergency or to accommodate essential activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and applicable approval has been granted.

8.0 PROGRESS REPORTING

Per 18 CFR §5.11(b)(3), this section describes provisions for periodic progress reports, including the manner and extent to which information will be shared; and the time allotted for technical review of the analysis and results.

A study progress meeting will be held in October of 2012. A study progress report (draft Technical Report) will be made available for 30-day stakeholder review and comment in November, 2012. Stakeholder comments will be addressed in the initial study report. The initial study report will be made available for review in mid January, 2013, followed by an initial study report meeting in late January, 2013. During the initial study report meeting, water quality data collected in 2012 will be reviewed with interested stakeholders. Based on this review, a determination will be made by PacifiCorp, in consultation with the interested stakeholders, as to whether additional data collection is warranted in 2013. The decision to conduct further monitoring will be based on, but not limited to, meeting the state water quality standards (as discussed in section 7.0 Study Methodology), and atypical climate and hydrology conditions that may have occurred during 2012. If a second year of data collection is warranted, a second year progress report (updated draft Technical Report) will be made available for 30-day stakeholder review and comment in November, 2013. Stakeholder comments will be addressed in the final Technical Report as described in the following section.

[8] Nephlometric Turbidity Unit
[9] Background turbidity will be determined using data from the EFI, RPI, and WFI sites, which represent inflow sites unaffected by the Project.

9.0 FINAL PRODUCT

A final Technical Report will be made available for stakeholder review in June, 2013 assuming one season of data collection is sufficient. If a second year of data collection is warranted, the final Technical Report will be made available in January, 2014. The final Technical Report will include descriptive text, maps, and data tables and will describe study objectives, methods, and the final results. This report will discuss any Project effects on existing water quality conditions, with reference to water quality standards, and document compliance with the standards. The report will describe the location and timing of exceedences, if any, of the water quality numeric criteria and whether or not such exceedences are due to Project effects.

The Final Technical report will be prepared in a manner and in a format to support application to the DEQ for Section 401 water quality certification.

10.0 SCHEDULE

The schedule or timeline for sampling is indicated in Table 6.4-1, and the overall schedule for the study is summarized in Table 10.0-1. As described in section 6.4 above, monitoring of flow will occur over a one-year period. Monitoring of water temperature also will occur at gage sites (i.e., EFI, RPI, BPU, BPL, and PHT) over the same one-year period. Given that gage installation is planned to occur during relatively low-flow conditions in fall 2011, and pending study plan approval, the one-year period will likely occur from about January 2012 to January 2013. Installation of thermographs at the additional water temperature sites (WFI and WRC) will likely occur at the same time as gage installation. Therefore, monitoring of water temperature at the additional water temperature sites also will occur from about January 2012 to January 2013.

Monitoring of dissolved oxygen will occur during August and September 2012. Monitoring of TDG will occur monthly as discrete sampling over a 2-day period from June through September. Monitoring of turbidity will occur for a multi-day period during forebay maintenance, which would be scheduled to occur sometime from May to August 2012.

Table 10.0-1 Schedule for the implementation of the Water Resources Study.

Component	Completion Date
First year of data collection	January 2012 – January 2013
---Flow gaging and water temperature data collection	January 2012 – January 2013
---Dissolved oxygen monitoring	August - October 2012
---TDG sampling	June – September 2012
---Turbidity monitoring	May – August 2012
Study Progress Meeting	October 2012
Study Progress Report	November 2012
Initial Study Report filed with FERC	January 2013
Initial Study Report meeting	January 2013

Component	Completion Date
Meeting Summary filed with FERC	February 2013
Final Technical Report*	June 2013
Updated Study Plan for second year**	March 2013
Second year of data collection**	May 2013 – October 2013
Second year Study Progress Report**	November 2013
Final Technical Report filed with FERC**	January 2014
Final Technical Report meeting**	January 2014
Meeting Summary filed with FERC**	February 2014

** Assumes one year or data collection.*

*** If a second year of data collection is determined necessary by PacifiCorp and stakeholders during the initial study report meeting.*

11.0 LEVEL OF EFFORT AND COST

PacifiCorp estimates an approximate cost of $84,200 for the study (Table 11.0-1). An approximate cost of $46,600 is estimated for the first year of data collection, which includes labor hours, per diem and travel costs, and the purchase of necessary field equipment and instruments. An approximate cost of $23,400 is assumed for the second year of data collection, based on an effort equivalent to about half of the estimated costs of the first year of study. This is an assumption only, given that the needs for the second year of data collection are yet to-be-determined in consultation with interested stakeholders.

Table 11.0-1 Anticipated level of effort and cost for components of the Water Resources study.

Activity	Labor	Per-Diem	Materials and Equipment	Total
First year of data collection	$38,200	$3,400	$5,000	$46,600
Second year of data collection	$19,100	$1,800	$2,500	$23,400
Reporting and meetings	$14,200	$0	$0	$14,200
Total	**71,500**	**5,200**	**7,500**	**84,200**

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