Black Canyon Hydroelectric Project
FERC Project No. P-14110
Revised Water Quality Study Plan
January 2013

Prepared for
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1 INTRODUCTION

Black Canyon Hydro, LLC, (BCH) ultimately plans to file an application for an original license for the Black Canyon Hydroelectric Project (Project), FERC Project Number P-14110, and associated facilities on the North Fork Snoqualmie River (North Fork), approximately 4 miles northeast of North Bend in King County, Washington. The Project has a proposed generation capacity of 25 megawatts (MW) and would be located entirely on private lands.

Intake Alternative A

Alternative A would consist of the following new facilities: (1) an 8-foot-high, 162.4-foot-long inflatable rubber diversion with an associated water intake structure; (2) a natural or roughened fish passage channel; (3) a variable pooling area behind the diversion with a normal water surface elevation of 971 feet above mean sea level and a maximum pooling of 2.83 acres; (4) a power conduit tunnel consisting of an approximately 450-foot-deep vertical tunnel into an approximately 8,350-foot-long, 9-foot-diameter horizontal tunnel and penstock; and (5) for access, Alternative A would utilize an existing logging road to minimize disturbance, and require only 825-feet of additional road.

Intake Alternative B

Alternative B would consist of the following new facilities: (1) a control sill to maintain a consistent river bottom elevation, which would allow water, fish, sediment, large woody debris, and whitewater recreationists to pass unimpeded, with an associated water intake structure; (2) a power conduit tunnel consisting of an approximately 450-foot-deep vertical tunnel into an approximately 9,175-foot-long, 9-foot-diameter horizontal tunnel and penstock; and (3) for access, Alternative B would utilize an existing logging road to minimize disturbance, and require only 500-feet of additional road.

Powerhouse

The power conduit tunnel and penstock from either Alternative A or B would terminate at the powerhouse proposed upstream of Ernie's Grove. Initially, the PAD described the powerhouse as being a metal building approximately 60-feet-wide by 100-feet-long. However, as a result of construction from the power conduit tunnel, an underground powerhouse of similar dimensions may be feasible. Tailrace dimensions have also been revised from a 60-foot-wide by 100-foot-long tailrace, to a 24-foot-wide by 200-foot-long tailrace. Whether above or below ground, the powerhouse would include two Francis turbine generator units, one rated at 16 MW and the other rated at 9 MW, as well as appurtenant facilities (switchyard, maintenance building, etc.). Additionally, a

temporary, 2,600-foot-long construction access road would extend from the powerhouse to the North Fork Road (while avoiding Ernie's Grove).

Transmission

As presented in the PAD, transmission would consist of a 4.2-mile-long, 115-kilovolt overhead transmission line that transmits project power to the regional grid (transmission line would be an over-build of an existing transmission line with only approximately 0.65 miles of new transmission). However, an additional option, depending on minimum instream flow requirements, land use designations, and cost, may be to have the Project connect to the existing 34 kV transmission line running from the existing Black Creek Hydroelectric Project to Snoqualmie Falls. A transmission line could be run from the powerhouse back through the power conduit to the intake structure. From the intake structure a buried or overhead transmission line would only have to travel approximately 6,745-feet along an existing logging road through clear cuts.

The project would operate in run-of-river mode. The combined maximum hydraulic capacity of the two project turbines would be 900 cubic feet per second (cfs). The project would divert water from a 2.6-mile-section of the North Fork Snoqualmie River.

BCH filed a Notice of Intent (NOI) and the associated Pre-Application Document (PAD) to commence the FERC Integrated Licensing Process on March 27, 2012. In response to the subsequent study requests filed by FERC staff and other stakeholders and as detailed in 18 CFR 5.11, BCH is required to submit relevant resource study plans. This includes a study of water quality near the Project reach which follows the requirements of 18 CFR 5.11(b)-(e).

2 STUDY DESCRIPTION AND OBJECTIVES

In accordance with 18 CFR §5.11(d)(1), this section describes the goals and objectives of the study and the information to be obtained. The goals and objectives of the water quality study are to use existing and new data to develop a detailed understanding of the factors that influence water quality in the project reach and within the North Fork watershed. Historic information will be compiled and existing/baseline conditions will be monitored and documented. An in situ monitoring plan will be developed and proposed to ensure that water quality guidelines are being met.

The water quality study will include the following elements:

- Literature review of existing stream flow, temperature, suspended sediment data**,** and other available water quality parameters collected by the U.S. Geological Survey or other entities;
- Water temperature modeling and verification monitoring to determine the effects of project operation on water temperatures;
- Water quality sampling for dissolved gases, turbidity, nutrients and pesticides.
- Help generate the information necessary to complete the water quality management plans to be submitted with a License Application.

3 STUDY AREA

The water quality study area includes the North Fork from immediately above the proposed Intake Alternative 'B' (approximately river mile 5.2), and any upstream pooling, to the confluence with the Middle Fork Snoqualmie River. This area was selected to cover the full extent of potential project impacts relating to changes in water quality while avoiding as many inputs unrelated to the proposed project as possible in the larger Snoqualmie River basin.

4 RESOURCE MANAGEMENT GOALS

In accordance with 18 CFR §5.11(d)(2), this section describes resources management goals of agencies or Indian tribes with jurisdiction over the resources to be studied.

Section 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the Project, as well as power and developmental values.

Describing the project effects on water quality in the area of disturbance related to Project construction and operation is necessary to fulfill the Commission's responsibilities under the National Environmental Policy Act (NEPA). Ensuring that potential water quality impacts related to the Project are analyzed is relevant to the Commission's public interest determination.

The Washington Administrative Code (WAC) 173-507 is a rule created in 1988 to regulate water for the Snohomish Basin. It includes all of the North Fork of the Snoqualmie River. This river's point of compliance for instream flow is at river mile 2.2, below where a powerhouse is proposed. This new hydropower project, if built, would

route water through a pipe from an intake several miles upstream and thus bypass several miles of natural river, putting the water back just below the powerhouse but above the point of compliance gage established in the rule.

WAC 173-507-020(5) of the rule provides authority for defining additional stream management units and set additional compliance points. However, since the proponent will be required to obtain a power water right, Ecology's perspective is that a more effective way of protecting flows in the proposed bypass reach will be to condition that water right. Ecology may use the results of flow, habitat and water quality studies required in the FERC process to inform both our water right process and the 401 certification. The water right, when issued, has to provide sufficient flow to protect the public interest in the bypass reach which includes aquatic habitat and recreation.

5 EXISTING INFORMATION

In accordance with 18 CFR §5.11(d)(3), this section describes existing information on water quality in the Project area, and the need for additional information.

Changes in water quality resulting from water diversion for hydropower generation have been reported in the scientific literature (Kibleer 2011). Water quality parameters such as water temperature that are sensitive to changes in discharge have been linked to changes in habitat quality and structure, and corresponding shifts in the distribution and abundance of fish and macroinvertebrate species (Miller et al. 2007). Thermal response to flow reductions in the Project Reach is a function of stream size and orientation, hydraulic conditions, degree of shading, and the influence of groundwater inputs. Reductions in the volume of water in Project Reach may lead to temperature changes below diversions. These effects, however, may be increased interaction between surface water and groundwater; discharge reductions may be accompanied by a disproportionate increase in colder groundwater inputs. Based on modeled stream temperature effects of water diversion for hydropower production, Meier et al. [2003] reported that where solar radiation dominates energy budgets, diversion will increase water temperatures in dewatered reaches, whereas steep, shaded streams, in which energy dissipation from head loss over elevation gradients is the principal energy source, will resist temperature changes when dewatered (Kibler 2011).

The Washington Administrative Code (WAC) includes fresh water use designations and water quality standards associated with these water uses (WAC 173-201A-200 and WAC

173-201A-602). Table 7 summarizes the fresh water use designations for the North Fork, between its confluence with the Snoqualmie River main stem and river mile 17, where Sunday Creek meets the North Fork. The Project area is wholly within this segment of the North Fork. Significantly, the segment of the North Fork affected by the Project is designated for use as "Core summer salmonid habitat" and as "Extraordinary quality primary contact waters." Key identifying characteristics of core summer salmonid habitat are summer salmonid spawning or emergence (between June 15 and September 15), or adult holding; use as important summer rearing habitat by one or more salmonid species; or foraging by adult and sub-adult native char. The project reach is known to contain holding areas for adult rainbow trout.

Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids (Kaje, 2009). Extraordinary quality primary contact waters provide protection against waterborne illness for recreational users.

Water quality in the North Fork sub-basin is generally very good. The sub-basin is almost entirely forested within a patchwork of federal, state and private ownership. Over 97 percent of the sub-basin is forestry land. The final 2.5 miles of the North Fork flow through designated rural residential areas that include small-scale livestock and other agricultural operations.

According to the Snoqualmie Watershed Quality Synthesis Report (Kaje, 2009), the North Fork showed no evidence of water quality impairment except for temperature; however, the North Fork sub-basin is a basin of concern for temperature during the summer months despite the area's forested nature. There have been minor failures to meet standards; however, in some cases the failure may have been a localized problem. Forestry practices and natural conditions are the most likely causes of high temperatures (Kaje, 2009). The presence of a broad, low-gradient, east-to-west oriented valley in the upper basin also may naturally promote warm temperatures. The valley aspect is very exposed to late summer solar heating, and the effect may be compounded by a slow, meandering river channel.

5.1 Temperature

The Snoqualmie River Basin Temperature Total Maximum Daily Load Water Quality Improvement Report and Implementation Plan (Ecology 2011) included data on the Snoqualmie River Basin temperature total maximum daily load (TMDL). In 2006, the North Fork met the state temperature standard of 16 °C near the Middle Fork confluence,

except for a critical period lasting 1 to 2 weeks. Natural conditions contribute to these warm temperatures in the North Fork. The channel migration zones for portions of the upper North Fork are wide, allowing for considerable solar input even when mature riparian vegetation exists. Tree heights also appear to vary suggesting that shading on portions of the North Fork will likely improve over time as trees mature (Ecology, 2011).

The North Fork basin is a "basin of concern" for water temperature (Kaje, 2009). The 16°C 7-day average of the daily maximum temperatures (7-DAD Max) standard applies to the North Fork as far upstream as the Sunday Creek confluence, in the middle of the valley described above. The 12°C standard applies to the river and associated tributaries further upstream.

During Ecology's TMDL effectiveness study, temperature near the mouth of the North Fork (at 428th Avenue SE) exceeded the 16°C standard on a few occasions, but summer sampling was limited to the month of August (Ecology, 2008). Ecology's draft temperature TMDL study collected continuous data in the summer of 2006 at the same location (Ecology 2006). The standard was exceeded for approximately three weeks in July, with a maximum 7-DADMax value of 19.0°C (Figure 7). Lacking data from locations upstream, the spatial extent of the temperature problem is unclear, and we cannot determine whether the upper basin is meeting the more stringent 12°C standard. Based on comparable data from the Middle Fork and from the Tolt River sub-basin, violations of the more stringent standard are highly likely.

The North Fork is cooler than the Middle Fork by several degrees, according to Ecology's continuous data from July 2006. That finding is supported by thermal infrared data collected during the same period – the North Fork has a discernible cooling influence on flow from the Middle Fork (Figure 8).

5.2 Fecal Coliform Bacteria

Ecology's 2008 water quality effectiveness monitoring report contains information on fecal coliform bacteria in the Snoqualmie River basin in 2008. The North Fork site met water quality standards for fecal coliform bacteria during the critical period, wet season, and all months, with the exception of August (2003–2005). Fecal coliform results for the August 23 to 24, 2004 sampling events indicate that many sites violate the second part of the fecal coliform bacteria standard for August (10 percent of all samples obtained for calculating the geometric mean shall not exceed 100 colony-forming units per 100 milliliters [cfu/100 mL] for this site). One sample event (130 cfu/100 mL) in August (n=9) caused the water quality standard violation.

Fecal coliform concentrations and loading estimates for this site are presented in Figures 9 and 10. Loading was estimated using flow discharge from the U.S. Geological Survey (USGS) Gage 12142000 at the North Fork, river mile 9.2, just upstream of Calligan Creek. The sampling site for the North Fork was at approximately river mile 0.5. Only three flow discharge measurements were obtained at this sampling site, so a flow curve could not be developed due to limited data. The three low-flow season measurements obtained at the sampling site ranged from 30–60 percent higher than flows at the USGS gage.

According to the Snoqualmie Watershed Water Quality Synthesis Report, the North Fork is not impaired by fecal coliform bacteria (Kaje, 2009). The entire length of the North Fork is classified as Extraordinary Primary Contact for purposes of fecal coliform standards. This means that the applicable fecal coliform limits are lower by half than most areas in the watershed, i.e., 50 cfu/100 ml for the geometric mean standard, and no more than 10 percent of samples shall exceed 100 cfu/100 ml.

According to Ecology, the North Fork had a geometric mean concentration of only 7 cfu/100 ml during the 2003–2005 study (Ecology 2008). Like most other locations in the watershed, the North Fork experienced a relative spike in concentration following a rain event after a prolonged dry spell in August 2004. The spike measured only 130 cfu/100 ml, much lower than the South Fork (500 cfu/100 ml) on the same date, and lower than other sites such as Kimball Creek, which measured 2,300 cfu/100 ml. This is unsurprising given how few human activities occur within the North Fork sub basin, with the exception of forestry.

5.3 Dissolved Oxygen

Available data shows that dissolved oxygen (DO) concentration meets state standards in the North Fork. The King County Department of Transportation Roads Maintenance Section has recorded very high DO year-round at two Tate Creek monitoring locations (>10 milligrams per liter [mg/L]). Unnamed tributary site E1051 also has recorded high values with no excursions below the standard since 2000. The fourth Roads Maintenance Section site (E1016) has similarly high values during winter and spring, but the site is often nearly dry in summer and has recorded occasional lower values during very low flow periods.

Ecology's TMDL effectiveness study concluded that the North Fork meets the DO standard based on data collected at the 428th Avenue SE location (Ecology, 2008).

5.4 pH

According to Ecology, the North Fork mainstem meets standards for pH, as do tributary sites monitored by the King County Roads Maintenance Section (Kaje, 2009).

5.5 Nutrients

Nitrogen and phosphorus levels were generally low in the North Fork. Orthophosphate levels were well below recommended main stem TMDL targets during all but one sample event. The mean orthophosphate level was 5 micrograms per liter (µg/L) (n=14) during the critical period.

No phosphate data was collected on the North Fork in the original TMDL study so a comparison could not be made.

5.6 Additional Information Needs

Additional information needed includes:

- Water quality data specific to the Black Canyon reach, including baseline inputs from upstream, factors influencing water quality within the reach under both existing and proposed conditions, and existing conditions downstream of the Black Canyon project area.
- Water quality data from the City of Snoqualmie Canyon Springs water supply to use as additional information for comparison. The City of Snoqualmie data will be obtained as part of the concurrent Groundwater Study Plan and the information will be shared and integrated.

6 NEXUS TO PROJECT

In accordance with 18 CFR §5.11(d)(4), this section describes any nexus between Project operations and water quality.

The proposed project would divert up to 900 cfs of water from the North Fork of the Snoqualmie River at river mile 5.1 and return the water to the river at river mile 2.5, after directing it through the tunnel, vertical shaft, turbines and tailrace. This alternative route has the potential to increase temperatures and influence other water quality parameters.

7 METHODS

In accordance with 18 CFR §5.11(d)(1) and §5.11(d)(5), this section provides a detailed description of the proposed study methodology, including data collection and analysis

techniques, or objectively quantified information, sampling strategy, and a schedule including data collection and analysis techniques, or objectively quantified information, sampling strategy, and a schedule including appropriate field season(s) and the duration (see "Schedule" heading below for schedule).

7.1 Literature Review of Existing Data

The first task will be to compile all existing data that are relevant to water quality in the project area. This may include water quality parameters measured in prior studies (e.g., Ecology 2011) and ongoing temperature monitoring recorded at two stream gages installed at the ends of the Project Reach by BCH in mid-September 2012, and flow data from USGS gages.

7.2 Water Quality Monitoring – Baseline

Baseline/existing water quality conditions will be monitored to determine if the current numeric water quality standards (listed in WAC 173-201a) are being met and to develop, as a PM&E measure, an on-going post construction monitoring plan, and to gather reach-specific data for informing the temperature model (see Section 7.3). Temperature loggers will be installed at the two project stream gage locations located at the Alternative 'B' Intake site and just below the powerhouse tailrace return site. Data loggers will be programmed to sample at fifteen minute intervals and provide a nearly continuous record of water temperatures across the project area.

Temperature is the highest priority parameter to measure, because it is the sole parameter that has had a known naturally occurring excedance within the project vicinity and has substantial biological relevance, but other parameters also will be monitored. For example, dissolved oxygen and turbidity will be measured at discrete intervals including critical times of the year. Please see the below tables and the map in Appendix A to review monitoring locations, frequencies, and related parameters. Water quality parameters will be measured according to the analysis techniques and protocols described in the "Standard Methods for the Examination of Water and Wastewater," a joint publication of the American Public Health Association, the American Water Works Association, and the Water Environment Federation (APHA 1995).

Table 1. List of Sample Sites (and Their Associated Codes) for the Water Quality Parameter Study

Sample Site	Associated Code
Intake[1]	I
Powerhouse[2]	PH

1: The site of the upper stream gage described in Hydrology study plan and the site of the proposed Alternative B intake.
2: The site of the lower stream gage described in Hydrology study plan slightly downstream of powerhouse and the site of a historic USGS stream gage and point of control for WAC instream flow requirement.

Table 2. Water Quality Study Summary of Parameters and Sampling Frequency by Site

Parameter	I	PH	Frequency
Temperature	•	•	Continuous
Dissolved Oxygen	•	•	Monthly
pH	•	•	Monthly
Turbidity	•	•	Flow Range[1]
Dissolved Gas	•	•	Monthly
Pesticides	•	•	Seasonally[2]
P & N Nutrients	•	•	Seasonally[2]

1: Flow Range: sampling will occur 10-12 times at a full range of representative flows over study period.
2: Seasonally: spring runoff, summer, fall, and winter.

7.3 Water Temperature Modeling

BCH will develop a water temperature model for the project reach to help predict project impacts. The model will allow for predictions to be made about project effects on water temperature.

For hydroelectric projects utilizing a long tunnel, the Washington Department of Fish and Wildlife recommends an evaluation of:

- Heat conduction from the walls of the tunnel during low diversion flow; and
- Energy dissipation heat gain in the powerhouse bypass valve or through a turbine operating inefficiency at maximum diversion flow.

7.4 Water Quality Monitoring – Compliance

BCH expects that water quality monitoring will occur post-license and be included as a license article. Temperature monitoring stations would likely be installed or maintained at a number of locations. Also, the same sampling protocols used for baseline monitoring will likely be continued. These results will help verify compliance with water quality requirements.

8 PROGRESS REPORTING

In accordance with 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.

Study reports will be submitted as required by the FERC Integrated Licensing Process (ILP). The most recent schedule, issued by FERC in Appendix B of Scoping Document 1, includes a number of opportunities for progress reports, exchange of analysis and results between stakeholders, and information sharing. After proposed study plans are filed with FERC there will be a study plan meeting and comment period before a revised study plan is filled and a comment period passes. Once studies begin, the ILP also has deadlines for an Initial Study Report to be submitted, an Initial Study Report Meeting, and an Initial Study Report Meeting Summary. However, this schedule is subject to change by FERC staff and should not necessarily be relied upon. It is BCH's understanding that any changes to the ILP plan and schedule will be noticed by FERC staff.

Prior to the completion of the Initial Study Report, BCH will provide an opportunity for technical review of the draft study results and analysis. When the draft version of the Initial Study Report has been completed, it will be posted to the project website (www.blackcanyonhydro.com) and BCH will send notice of its availability by e-mail to contacts included on the mailing list identified in the "Revised Communication and Information Protocol" (filed electronically with the FERC on November 27, 2012). Stakeholders will have 15-days from the issuance of this notice to provide written comments to BCH through the project website's "Contact" tab.

9 SCHEDULE

In accordance with 18 CFR §5.11(b)(2), the schedule for conducting the study is provided in Table 1 below.

Table 3. Water Quality Study Schedule

Component	Completion Date*
Literature Review	May-June 2013
Baseline Water Quality Monitoring	May-October 2013
Water Temperature Modeling	August-November 2013
Compliance Water Quality Monitoring	To Be Determined
Draft Initial Study Report Notice &	Winter 2013

Informal Comment Period	
Initial Study Report Due	February 6, 2014

*Dates based on schedule created and presented by FERC in Scoping Document 1 and subject to change.

10 LEVEL OF EFFORT AND COST

In accordance with 18 CFR §5.11(d)(6), the anticipated level of effort and cost are provided in Table 2 below.

The estimated cost of this work is approximately $41,000. Any ongoing compliance monitoring would be an additional cost.

Table 4. Level of Effort and Cost

Task	Labor and Expenses
Literature Review	$5,000
Baseline Monitoring	$26,000
Temperature Modeling	$10,000
Compliance Monitoring	To Be Determined
Total	$41,000

11 REFERENCES

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Ecology. 2008. Snoqualmie River Basin Fecal Coliform Bacteria, Dissolved Oxygen, Ammonia-Nitrogen, and pH Total Maximum Daily Load Water Quality Effectiveness Monitoring Report. Prepared by Debby Sargeant and Ralph Svrjcek. Publication No. 08-03-005. March.

Ecology. 2011. Snoqualmie River Basin Temperature Total Maximum Daily Load Water Quality Improvement Report and Implementation Plan. Prepared by Anita Stohr, James Kardouni, and Ralph Svrjcek. Publication No. 11-10-041. June.

12 APPENDIX A: Water Quality Study Area