Black Canyon Hydroelectric Project
FERC Project No. P-14110
Revised Hydrology Study Plan
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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 overbuild 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 hydrology within 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 this study are to (1) evaluate existing hydrology of the North Fork as it relates to the proposed Project, including flow statistics at locations identified in Section 3.0; (2) to assess potential

changes to the flow regime in the Project Reach that would result from alternative project operational modes; and (3) determine the potential for catastrophic failure of the diversion, and concomitant flooding of areas downstream of the bypass reach.

Representatives of local, state and federal governments and tribes, and other stakeholders who commented on the PAD, submitted study requests, and commented on the proposed study plans, raised issues related to hydrology, including project operations and economic viability; downstream flood risks; water quality (including water temperatures); aquatic habitat; sediment and large woody debris transport; channel stability; and recreational fishing and boating. The hydrology study will be coordinated with other studies that address these issues to ensure that they are informed by the best available information on existing hydrologic conditions and potential effects the project might have on the frequency, magnitude, timing, duration, and rate of change of flows in the North Fork.

The Hydrology Study will be carried out to achieve the following specific objectives:

- Objective 1: Simulate historic daily streamflow at RM 5.1 (point of diversion) and RM 1.9 (downstream of powerhouse), by correlating hydraulic monitoring information collected at the intake and powerhouse locations with data from the existing USGS gage 12142000;
- Objective 2: For each location, using simulated historic daily streamflow, determine streamflow parameters including annual and monthly flow-duration curves, and statistics needed for other study elements including – key biological and recreational processes and activities addressed in other study plans.
- Objective 3: Evaluate the potential risk of downstream flooding due to catastrophic failure of the diversion.

3 STUDY AREA

The hydrology study area will include the North Fork Snoqualmie River sub-basin from just upstream of the diversion point (RM 5.1) to just past the powerhouse return to the river (RM 1.9). The 2.6-mile long project reach is bounded at its lower end by the tailrace discharge point and at its upper end by the pool that will be formed by the diversion (RM 5.1).

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 hydrology 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). Analyzing the hydrology related to the Project is relevant to the Commission's public interest determination.

5 EXISTING INFORMATION

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

Streamflow data for the North Fork in the vicinity of the project has been collected at three USGS streamflow gaging stations. USGS gage 12142000, located 4.3 miles upstream of the proposed diversion point, has been operational more or less continuously since 1930. USGS gage 12143000, located slightly below the point where water from the proposed powerhouse tailrace will be discharged back into the North Fork, was operated intermittently beginning in 1909, but was decommissioned in 1971. USGS gage 12142500 was operational for two years: 1915-1916. A table summarizing operational histories of USGS stream gaging on the North Fork is shown below, Table 1.

Table 1 – USGS stream gage locations and operational history summary.

USGS Gage Identifier	Period of Operation	Location
12142000	Discharge 10-1-1929 - Present Stage 08-10-1985 - Present	Lat: 47^0 36' 54" Long:-121^0 42' 44" Approximately 1 mi upstream of confluence with Calligan Creek
12142500	Discharge 10-01-1913 - 9-30-1915	Lat:47^0 34' 20" Long:-121^0 42' 50" Approximately 600 feet upstream of confluence with Hancock Creek.
12143000	Discharge 08-01-1907 - 08-31-1971	Lat:47^0 32' 15" Long:-121^0 44' 26" Approximately 2 mi upstream of confluence with Snoqualmie River.

Streamflow data available through the online USGS web portal include annual and peak flow statistics, daily mean flow, and "instantaneous flow" recorded at 15-minute to hourly intervals at USGS Gage 12142000 from October 1, 1987 through September 30, 2007, and for the most recent 120 days (USGS 2012a-f). Additional 15 minute to hourly flow data recorded at the same station after October 1, 2007, are available upon request from the USGS Washington Science Office (USGS 2012g).

The USGS also provides on-line tools to estimate watershed parameters and peak flows for ungaged watersheds. These tools can be used to further characterize the watershed and help identify appropriate transfer functions to relate flow at one point on the North Fork (e.g., USGS Gage 12142000) to other points on the North Fork (e.g., point of diversion and point of return).

In addition to streamflow data that will be retrieved from online sources, additional information will be obtained from the Washington Department of Natural Resources (one of the local sponsors of USGS Gage 12142000) or the USGS Water Science Office for Washington. These offices may have access to flow data since October 2007 with greater resolution (15-minute to hourly) than the mean data published online by the USGS.

Black Canyon Hydro, LLC has installed new continuously recording streamflow gages immediately upstream of the proposed water intake structure and downstream of the tailrace discharge point on the North Fork. These two stream gages were installed, and began recording data, on September 13 and 14, 2012.

6 NEXUS TO PROJECT

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

Given the anticipated operational and regulatory constraints, the likely effect of the project on flows in the project reach relative to existing conditions will be:

- No change in the frequency or duration of very low flows, since the project will not be operated during the lowest summer baseflow period;
- A reduction in flow magnitudes and variability when natural flows at the diversion point exceed environmental flows by up to 900 cfs (i.e., the maximum project design flow range);
- An increase in the frequency and duration of low flows, and a decrease in the frequency and duration of moderate flows;

- No change in the frequency and timing of high flows, and a slight decrease in their magnitude and duration.

Unlike conventional hydropower projects that store and release water to generate electricity when needed, the Black Canyon Hydroelectric Project will operate in run-of-the-river mode. When generating, as water is diverted, an equal volume of water is also being returned to the North Fork downstream and there would be no significant alteration on North Fork flows downstream of the powerhouse.

Project-induced changes in flow may affect other biophysical processes and beneficial uses of the North Fork within and downstream of the project reach, including large wood and sediment transport, fish habitat, water temperatures, and recreational boating.

This study will inform project design and management with the goal of avoiding or mitigating unwanted project impacts.

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 Objective 1: Simulate historic streamflow at RM 5.1 (point of diversion) and RM 1.9 (downstream of powerhouse).

- Hydrologic data collected by USGS at the 12142000 gage will be used to synthesize hydrology at the proposed point of diversion (RM 5.1) and at the point of return to the river (RM 1.9). The methodology for simulating streamflow at these locations utilizes the unit area discharge of the 12142000 gage and applies it to the point of diversion and the powerhouse return to river. The applied unit area discharge is further refined by applying a daily factor which accounts for runoff and accretion from tributaries.

- The daily factor will be determined by utilizing information from the 12142000, NF Snoqualmie River near Snoqualmie Falls, and 12143000, NF Snoqualmie River near North Bend gages which were both in use 1-1-1962 through 1-1-1970.

The eight years of operation that these gages share allows the daily average discharge to be compared at both locations. The discharge measured at the 12143000 gage is divided by the discharge at the 12142000 gage to determine the percent accretion. After calculating the percent accretion for each day of each year a daily average will be taken, this is the daily average factor. A ten day average of the daily average factor will be calculated to smooth the daily average factor, this is the daily factor.

7.2 Objective 2: For each location, streamflow parameters and statistics will be developed using time periods of meaningful duration.

- Flow duration curves will be prepared for each streamflow measurement location (USGS Gage 12142000, diversion point, and powerhouse return point), as well as annual and monthly mean, minimum, and maximum flow statistics. Additionally, minimum and maximum daily flow for the period of record will also be summarized.
- Peak flows will be estimated using Log Pearson Type III distributions for each monitoring location for the 2-,5-, 10-, 25-, 50-, and 100-year events.
- Hourly data and, potentially, 15 minute data will be analyzed to evaluate short-duration effects, such as the North Fork's response to precipitation events, diurnal variation in flows due to snowmelt, and flows during daylight-hour periods that would accommodate fishing and boating activities. A synthesis of this data will appear throughout other related study plans.
- Prepare summaries for time periods which may be associated with key biological and recreational processes or activities to support other studies. These may or may not include temporal life cycle activities of fish such as juvenile and adult migration; fishing, and recreational boating.

7.3 Objective 3: Evaluate the potential risk of downstream flooding due to catastrophic failure of the diversion under different project operation scenarios.

- Perform hydraulic routing analysis to model flooding as a result of diversion failure. Scenarios to be modeled include sudden release of water during low flow (e.g. mechanical failure) and at high flow (e.g. 100-year event) for all proposed project designs that alter natural river flow or have the ability to fail and release water. Scenarios will be modeled using LiDAR ground and water surface elevation information in conjunction with a 3 dimensional project model rendered in Civil 3D.

- Create a "Risk Reach Map" depicting 1-foot contours of maximum flood depth increase and time of concentration downstream from the point of release.
- Identify measures to prevent or mitigate significant effects of flooding resulting from diversion failure.

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 2. Resource Study Schedule

Component	Completion Date*

~~Gage Installation~~	~~Fall 2012~~
Gage Monitoring	Ongoing
Construct a daily time series of historical streamflows at RM 9.3 (upstream of diversion), RM 5.1 (point of diversion), and RM 2.4 (point of return).	January – March 2013
For each location, select a representative time period and calculate statistical values for key streamflow variables.	March – April 2013
Evaluate the potential risk of downstream flooding due to catastrophic failure of the diversion under different operational scenarios.	January – May 2013
Draft Initial Study Report Notice & Informal Comment Period	Winter 2013
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.

Table 3. Level of Effort and Cost

Task	Labor and Expenses
Gage Installation	$35,770
Gage Monitoring	$35,200
Simulate historic streamflow at RM 5.1 (point of diversion) and RM 1.9 (downstream of powerhouse).	$2,500
For each location, streamflow parameters and statistics will be developed using time periods of meaningful duration.	$2,500
Evaluate the potential risk of downstream flooding due to catastrophic failure of the diversion under different project operation scenarios.	$14,000
Total	$89,970

Beyond gage installation and monitoring, one principal hydrologist/engineer would be expected to review existing data sources; obtain archive flow data from USGS for the

period October 1, 2007 to present; evaluate flow data (daily, peak, and instantaneous); assess potential trends (if any) in runoff based on climate change research prepared by others; coordinate with other studies; and draft and finalize maps and reports.

The principal hydrologist/engineer would be supported by additional staff and be aided by independent senior in-house staff for quality assurance/quality control review. Depending on the degree of success in conducting the flow assessment, it is possible that additional modeling of the rainfall-to-runoff process, including snowmelt, will be needed to complete the evaluation of potential effects. These costs can be estimated at a later time when the scope and need for that modeling are sufficiently developed.

11 REFERENCES

US Geological Survey (USGS). 2012a. USGS Current Conditions for USGS 12142000 NF Snoqualmie River near Snoqualmie Falls, WA. http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12142000. Accessed August 7, 2012.

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12 APPENDIX A: Hydrology Study Area & Features