From:	Steinmetz, Marcie
To:	"McKinney, Charlie (ECY)"; "Coffin, Chris (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Bitterman, Deborah; Sokolowski, Rosana
Subject:	Draft Water Quality Annual Report/FERC"s Annual Water Assurance Project Report and QAPP Update, 2014
Date:	Monday, March 02, 2015 9:19:09 AM
Attachments:	Appendix_B_Calibration_Report.pdf Appendix_C_data_loss_omissions.pdf Appendix_D_Daily_Maximum_Temperatures.pdf Appendix_E_2014_Annual_Gas_Abatement_Report.pdf 2015_Rocky_Reach_Annual_Water_Assurance_Project_Report_and_QAPP.docx

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PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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To: Chris Coffin, Washington State Department of Ecology
Charlie McKinney, Washington State Department of Ecology

From: Marcie Steinmetz
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145
License Article 401 – Water Quality Annual Report/FERC's Annual Water Assurance Project Report and QAPP Update, 2014

Mr. Coffin and Mr. McKinney:

Per Section 5.7(8) of the 401 Water Quality Certification for Rocky Reach, Chelan PUD hereby submits the Draft 2014 Annual Water Quality Monitoring Report/FERC's Annual Water Assurance Project Report and QAPP Update for your review.

Please review and submit your comments on or before 5:00 p.m., April 2, 2015 to me via email at marcie.steinmetz@chelanpud.org or fax (509) 661-8203.

Pursuant to the FERC Order Modifying and Approving Quality Assurance Project Plan, Chelan PUD will file the Final Water Quality Report with FERC by May 1, 2015.

All received comments will be appended to the final report with a description of how each comment or recommendation was incorporated in the report, or, if the licensee does not adopt a recommendation, the filing with the FERC will include the licensee's reasons, based on project-specific information for not adopting such recommendation.
If you have any questions, please do not hesitate to contact me.

Thank you,

Marcie Steinmetz | **Water Resource Specialist**

Chelan County Public Utility District No.1 | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

ROCKY REACH ANNUAL WATER ASSURANCE PROJECT REPORT AND QAPP UPDATE, 2014

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

April 15, 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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TERMS AND ABREVIATIONS

401 Certification	water quality certification
7-DADMax	seven day average of the daily maximum temperatures
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
CCT	Confederated Tribes of the Colville Reservation
CE-QUAL-W2	Water quality and hydrodynamic model in a longitudinal and vertical dimension
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FMS	fixed monitoring station
GBT	gas bubble trauma
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
MQO	Measurement data quality objective
NMFS	National Marine Fisheries Service
Project	Rocky Reach Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RRFF	Rocky Reach Fish Forum
standards	Washington State water quality standards
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan

EXECUTIVE SUMMARY

This annual water quality monitoring report (aka Quality Assurance Project Plan or QAPP Report) is being submitted to the Federal Energy Regulatory Commission (FERC) as required by the Order Modifying and Approving the Quality Assurance Project Plan Pursuant to Article 401 and Appendix A issued November 3, 2010.

A draft of this report was provided to the Washington Department of Ecology (Ecology) on March 2, 2015 for review and comment. Ecology provided comments on xxx. A copy of the consultation record, including Ecology's comments and Chelan PUD responses, is attached as Appendix G.

This report includes:

- the results of all sampling conducted in 2014
- conclusions regarding compliance with the project's water quality standards;
- recommendations for further action, if necessary;
- proposed actions to be implemented in 2015, and
- the annual update to the Quality Assurance Project Plan (QAPP).

Total dissolved gas (TDG) data were collected throughout the monitoring season at 15-minute intervals from January 1 through December 31, in the Rocky Reach forebay and tailrace and the Rock Island forebay (next downstream dam). The hourly averages of these readings were recorded on a computer located at the Public Utility District No. 1 of Chelan County's (Chelan PUD) headquarters for later use in daily calculations of TDG and temperature data.

Data analysis of TDG data during the fish spill season (April 1 through August 31) showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria of 115 percent on 32 days. TDG exceeded the modified Washington State water quality TDG criteria on 11 days in the Rocky Reach tailrace (120 percent), and 20 days in the Rock Island forebay (115 percent). These exceedances of the water quality criteria did not necessarily result in noncompliance, as many occurred when forebay TDG levels were above the numeric criteria. For instance some exceedances observed in the Rock Island forebay occurred when the upstream dam's forebay exceeded 115 percent. After eliminating exceedances that occurred when the upstream forebay exceeded 115 percent, the percentage of days TDG criterion was met are shown below:

Monitoring Location	Percent of Days Criteria Were Met
Rocky Reach Tailrace (125%)	98.0%
Rocky Reach Tailrace (120%)	93.5%
Rock Island Forebay (115%)	95.0%

Between January 1 and March 31, 2014, the non fish spill criterion of 110 percent was exceeded seven hours in the Rocky Reach tailrace (99.7 percent compliance with the TDG criteria), but not for any hours in the Rock Island forebay.

Between September 1 and December 31, 2014, the non fish spill criterion of 110 percent was not exceeded in the Rocky Reach tailrace or Rock Island forebay, resulting in 100 percent compliance with the TDG criteria.

Temperature data were collected April 1 through October 31 in the Rocky Reach forebay and tailrace at 15-minute intervals. These 15-minute intervals were averaged into hourly readings for use in compiling

daily averages, daily highs, and seven day average of the daily maximum temperatures (7-DADMax). Chelan PUD obtained Wells Dam tailrace hourly temperature data for April 1 through October 31 directly from the Public Utility District No. 1 of Douglas (Douglas County PUD).

A summary showing the percentage of days the 7-DADMax temperature criterion was met is shown below:

Location	Data Collection Period	# of Exceedances[1]	% of Days that Criterion was Met
Wells Tailrace	4/1–10/31	84[2]	
Rocky Reach Forebay	4/1– 10/31	85	60.3
Rocky Reach Tailrace	4/1-10/1	85	60.3

[1]State of Washington's Water Quality Standards designate a temperature criterion for the Project area of 17.5°C, except when a water body's temperature is warmer than 17.5°C and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. For the purposes of this report, "natural condition" is the background/incoming condition (i.e. Wells tailrace for the Rocky Reach forebay, and the Rocky Reach forebay for the Rocky Reach tailrace.
[2]Wells tailrace "exceedance" is simply an exceedance of the 17.5°C criterion. It does not take into account the "natural conditions" in the Wells forebay.

In addition to the annual program monitoring TDG and water temperature at the Project, additional water quality monitoring in the fishway and analysis of different spill gate sequences for abatement of TDG were reported.

Under Section 5.5(1)(a) of the 401 Certification, Chelan PUD is required to monitor water temperatures in the Juvenile Bypass System (JBS) and Upstream Fishway for one year, unless Ecology determines in consultation with the Rocky Reach Fish Forum (RRFF) that additional monitoring is required. The JBS and Upstream Fishway were monitored for temperature in 2012 and 2014 respectively. In 2014, minimum, maximum, and average daily water temperatures were similar within the Rocky Reach Upstream Fishway recorded during the study period. The data showed there was little differences in the 2014 daily average water temperatures of the forebay when compared to the Upstream Fishway average water temperatures.

Under Section 5.4(1)(b)(6) of the 401 Certification, Chelan PUD is required to implement alternative spillway operations, using any of gates 2 through 12, to determine, in consultation with the Rocky Reach Fish Forum (RRFF) and Habitat Conservation Plan Coordinating Committee (HCP CC), whether TDG levels can be reduced without adverse effects on fish passage. If effective in reducing TDG and not adversely affecting fish passage, Chelan PUD will implement the alternative.

Chelan PUD has identified four steps or phases necessary in order to complete the condition 5.4.(1)(b)(6). The identified phases are listed and discussed further in Section 3.1.1 of this report.

Phase 1. Develop and run test scenarios for spill gate configurations, collect data

Phase 2. Analyze the data collected during the test scenarios for TDG reduction

Phase 3. Further analyze the TDG reductions and potential effects on fish passage

Phase 4. If effective in TDG reduction without potentially affecting fish passage, develop an implementation plan in coordination and consultation; internally with Chelan PUD operations and externally with the RRFF and the HCP CC

Chelan PUD has completed Phases 1 through 3. The analysis in Phase 3 indicated that there may be a reduction in TDG levels for spillway volumes of 40 kcfs or greater if the flat spill pattern were used rather than the standard spill pattern. Chelan PUD has started Phase 4 by coordinating and communicating the results of the analysis with the RRFF and HCP CC.

There are no updates proposed at this time to the current Ecology/Federal Energy Regulatory Commission (FERC) approved QAPP (Chelan PUD, 2010).

SECTION 1: ***INTRODUCTION***

The Rocky Reach Hydroelectric Project (Project), owned and operated by Chelan PUD, is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project consists primarily of an 8,235-acre reservoir; a 2,847 foot long by 130 foot high concrete gravity dam spanning the river, including a powerhouse and spillway; a juvenile fish bypass system, and hatchery facilities.

FERC issued the order modifying and approving the QAPP for the Rocky Reach Project on November 3, 2010. The QAPP (Chelan PUD, 2010)(Appendix A) provided the basic framework for all the water quality monitoring and reporting required in the Rocky Reach 401 Certification.

The 401 Certification requires Chelan PUD to:

- Monitor TDG and temperature in the Project forebay and tailrace annually;
- Monitor temperature in the Upstream Fishway and JBS for one year, unless Ecology or the RRFF determines additional monitoring is required;
- Conduct a one-time study to monitor pH, dissolved oxygen (DO), and water temperature in shallow water areas (macrophyte beds) of the Rocky Reach reservoir, including areas that contain dense growths of aquatic macrophytes;
- Conduct a one-time study of Gas Bubble Trauma (GBT), and
- Compile hourly temperature data from the Wells Dam tailrace.

Section 5.7(8) of the 401 Certification requires the submittal of an annual report of water quality monitoring results, along with a summary report by March 1 of each year to Ecology. Ecology will use the monitoring results to track the Project's progress toward meeting and remaining in compliance with the state water quality standards. Additionally, the FERC order modifying and approving the QAPP requires the submittal of the same report to the FERC by May 1 of each year.

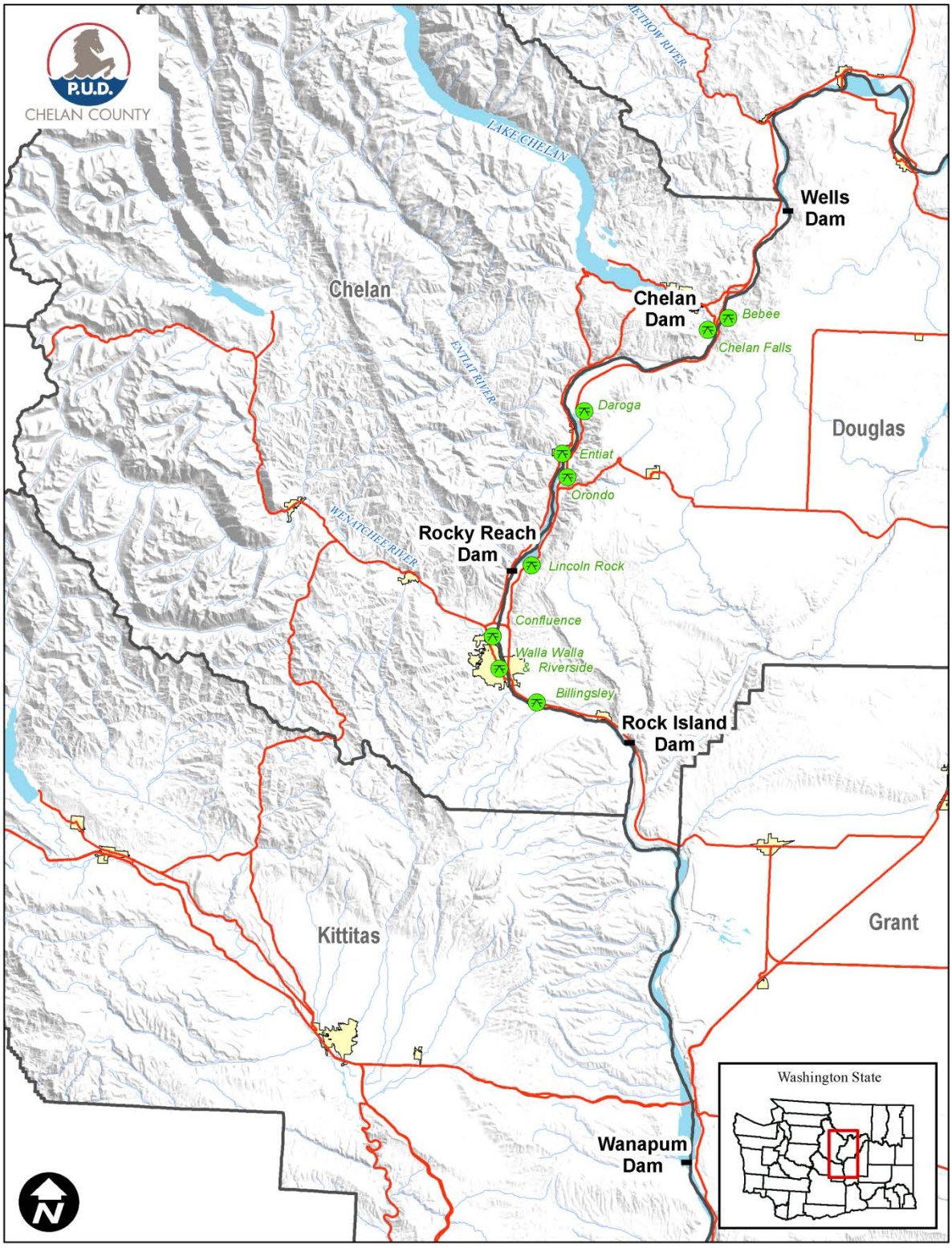

Figure 1-1: Location of the Rocky Reach Hydroelectric Project on the Columbia River.

SECTION 2: ***MONITORING PROCEDURES***

2.1 Forebay and Tailrace TDG and Temperature

TDG and temperature were monitored in the Project forebay and tailrace on an hourly basis, January 1 through December 31.

The forebay fixed monitoring station (FMS) is located on the upstream side of the dam (Figure 2-1), the standpipe affixed to the corner between the powerhouse and spillway, approximately mid-channel. Consistent with the 401 Certification (Ecology, 2006), the tailrace fixed monitoring station is located approximately 0.38 miles downstream of the dam (Figure 2-2). The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is east of mid-channel, and is minimally impacted by powerhouse flows when the project is passing water over the spillway (Schneider and Wilhelms, 2005). This location was chosen because it was the most feasible location near the end of the aerated zone, which is the compliance point for the Mid-Columbia TDG Total Maximum Daily Load (TMDL).

Forebay and tailrace TDG and temperature data were collected using instruments that can immediately transmit the data to Chelan PUD headquarters, allowing for real-time data recording. A multi-parameter instrument (Minisonde) developed by Hydrolab, Inc., equipped with TDG and temperature sensors, was lowered down the standpipe at each site and submerged to depth of approximately 15 feet.

TDG and temperature measurements were recorded throughout the monitoring season at 15-minute intervals. These 15 minute intervals were averaged into hourly readings for use in compiling daily and 12-hour averages for TDG and daily averages and daily highs for temperature. All hourly data were forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center and posted at their site on the World Wide Web at:
http://www.cbr.washington.edu/dart/query/river_graph_text.

Figure 2-1: Location of the forebay and tailrace FMSs, and the JBS entrances.

2.1.1 Alternative Spillway Operations

Under Section 5.4.1(b)(6) of the 401 Certification, Chelan PUD is required to implement alternative spillway operations, using any of gates 2 through 12, to determine, in consultation with the RRFF and HCP CC, whether TDG levels can be reduced without adverse effects on fish passage. If effective in reducing TDG and not adversely affecting fish passage, Chelan PUD will implement the alternative.

Chelan PUD has identified four steps or phases necessary in order to complete the condition 5.4.1(b)(6). The identified phases are listed and discussed further in Section 3.1.1 of this report.

Phase 1. Develop and run test scenarios for spill gate configurations, collect data

Phase 2. Analyze the data collected during the test scenarios for TDG reduction

Phase 3. Further analyze the TDG reductions and potential effects on fish passage

Phase 4. If effective in TDG reduction without potentially affecting fish passage, develop an implementation plan in coordination and consultation internally with Chelan PUD operations and externally with the RRFF and the HCP CC

In 2013 Chelan PUD contracted with Parametrix to analyze the data collected during the two seasons of testing to determine if any of the tested configurations had the potential to reduce TDG. Results of the study are summarized in Section 3.1.1.

2.2 Upstream Fishway and Juvenile Bypass Temperature

The required one year of temperature monitoring in the JBS was conducted in 2012 and reported in the 2013 Rocky Reach Annual Water Quality Monitoring Report.

In 2014, temperatures of the Upstream Fishway were monitored from mid March through the beginning of January. The following sections provide a synopsis of the water temperature data collection methods that were used to monitor water temperatures in the Upstream Fishway, including where the thermistors were placed, how the data was collected and analyzed, Quality Assurance/Quality Control (QA/QC) methods, and any issues with the data. The QAPP (Chelan PUD, 2010) provides additional details and specifications on the equipment used to monitor water temperature in the Upstream Fishway. Figure 2-2 provides a visual overview of the adult fishway and juvenile bypass system.

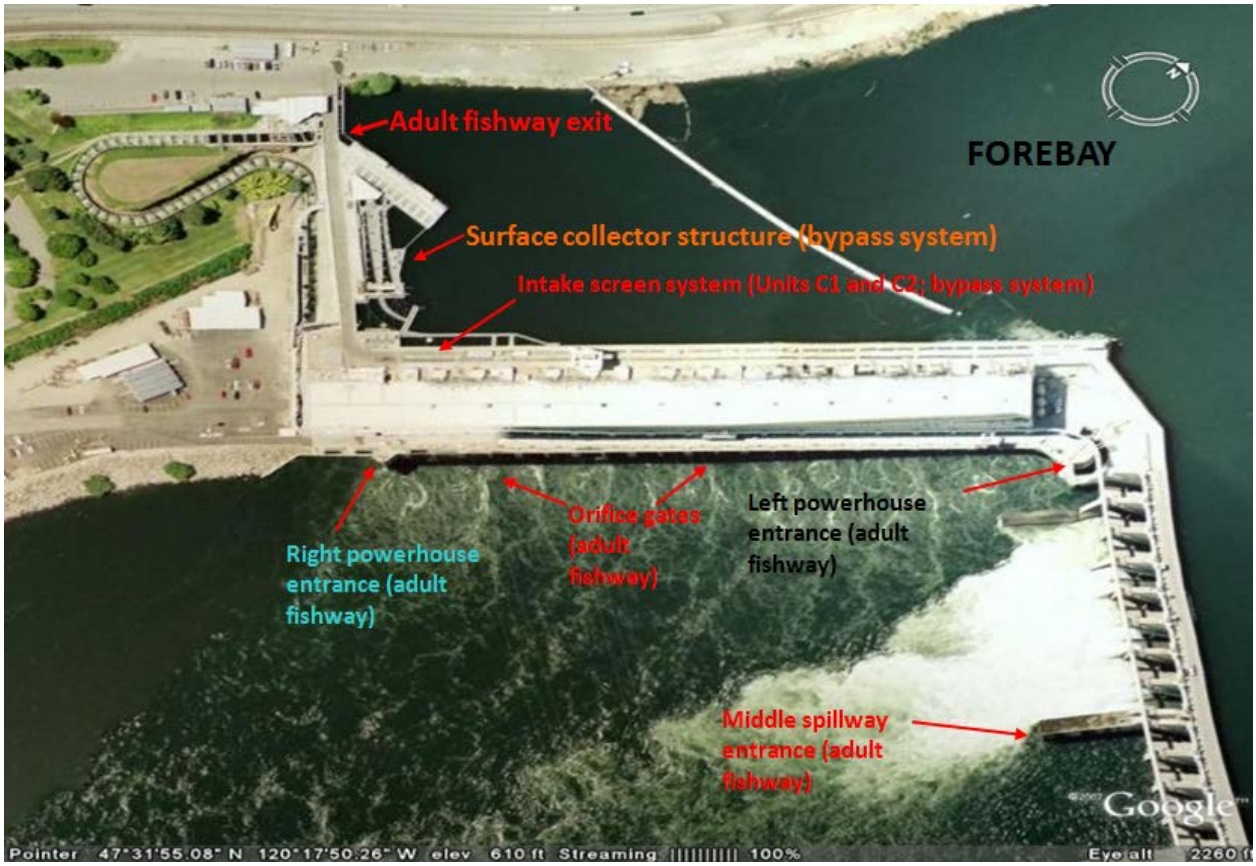

Figure 2-2: Rocky Reach Adult Fishway and Juvenile Bypass System

2.2.1 Thermistor Locations

Thermisters were placed in locations to monitor possible warming effects from weather conditions (ambient temperatures, solar radiation, etc.) at the water entrance or fish exit (Exit – T1 and T2), in the first pool below the diffuser (Mid – T3 and T4), and at the 90 degree pool (90º pool – T5 and T6) (Figure 2-2). The specific locations were chosen as follows:

Six, Onset® HOBO® Water Temp Pro v2 thermistors were installed in the Upstream Fishway in February 2014. The thermisters were installed in the Upper Fishway in the following manner (Figure 2-3);

- Exit-Two thermisters located the fishway exit
  - Both on the east wall, located in approximately the middle of the pool. One located at five feet off the fishway floor (T1), the other one foot off the floor of the fishway (T2).
- Mid-Two thermisters in the first pool below the diffuser located the upper end of the ladder
  - Both on the west wall, approximately two feet upstream from the weir. One located five feet off the fishway floor (T3), the other located one foot off the fishway floor (T4).
- 90º-Two thermisters in the 90 degree pool
  - Both on the southern wall, approximately two feet downstream from the weir. One located five feet off the fishway floor (T5), the other located one foot off the fishway floor (T6).

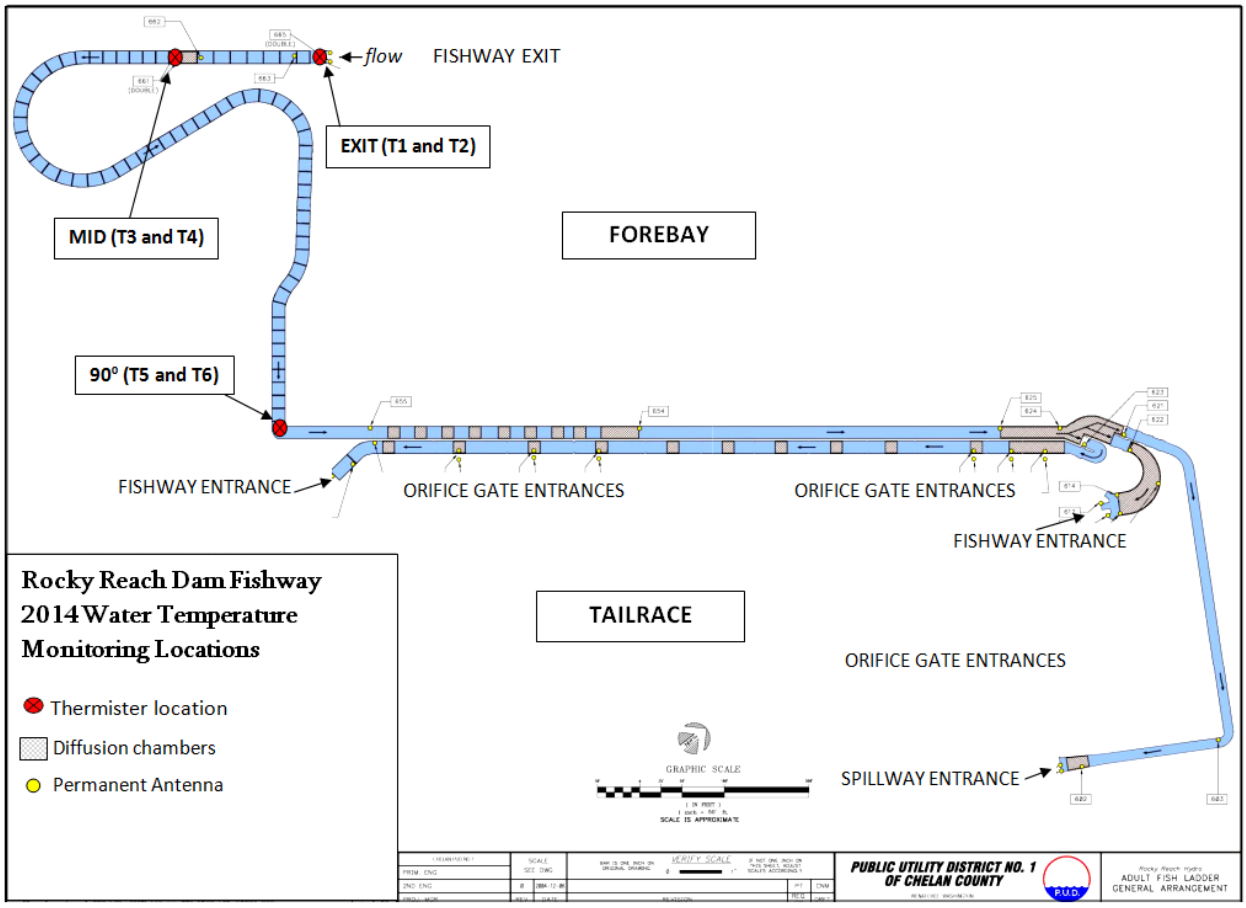

Figure 2-3: Rocky Reach Dam Fishway Temperature Thermister Locations

2.2.2 Data Collection

Hourly water temperature data was collected from the time the Upstream Fishway was re-watered and operational (March 15, 2014) and then de-watered (January 4, 2015). Data that corresponded to ambient air temperatures (thermisters out of the water), were removed from data used for the summary statistics.

Chelan PUD also used temperature data from the FMS of the forebay to compare them to the water temperatures within the Upstream Fishway. More details on the Rocky Reach forebay FMS are located in the previous Section 2.1.

2.2.3 Data Analysis

Water temperature was analyzed to determine if there was a significant difference between the upper and lower profiles of each sample site in the Upstream Fishway. Two thermisters were used at each monitoring location (Exit – T1 and T2, Mid – T3 and T4, and 90º pool – T5 and T6), one higher vertically attached to the fishway wall and one lower.

Data collected when the thermisters were out of the water in the Upstream Fishway were removed from the summary statistics. Water temperature information from within the fishway, along with data recorded at the forebay FMS were evaluated using daily averages, the 7-DADMax, minimum, maximum, and standard deviation. These results were reviewed to determine longitudinal and temporal differences within the Upstream Fishway and between the Upstream Fishway and forebay.

2.2.4 QA/QC

Upon data download of T1, the thermister was found to be non operational and sent back to the manufacturer for manual data retrieval. Chelan PUD anticipates receiving data recorded on T1 by February 1, 2015. For this water temperature evaluation, Chelan PUD used T2 only for the Exit location.

It is important to note as stated in the QAPP (Chelan PUD, 2010) that the manufacturer's stated accuracy of the thermistors used for monitoring the water temperature of the Upstream Fishway is ±0.2°C.

Data downloaded from the thermisters and the analyses of data are presented in Section 3.2.2.

2.3 Wells Dam Tailrace Temperature

Chelan PUD obtained Wells Dam tailrace hourly temperature data directly from Douglas PUD. The temperature data are discussed in Section 3.2.1.

2.4 GBT

Per Section 5.4(1)(c) of the 401 Certification, Chelan PUD shall conduct a one-time study of GBT. However, in a draft letter received by Chelan PUD on April 21, 2014, Ecology recommended Chelan PUD postpone any gas bubble trauma study on native fish and/or invertebrates until such time as it may be determined to be necessary. Ecology is currently evaluating the need for future GBT studies.

2.5 Macrophyte Bed DO, pH, and Temperature

Shallow water habitats in the reservoir, including macrophyte beds, were monitored for compliance with numeric criteria for dissolved oxygen, pH and water temperature during August and September of 2012 and reported in the 2013 Rocky Reach Annual Water Quality Monitoring Report.

2.6 Data Evaluation and Completeness (QA/QC)

2.6.1 Representativeness

TDG and temperature data were collected from locations as required by the 401 Certification and the Mid-Columbia River and Lake Roosevelt TDG TMDL. Data were collected hourly, which is at a frequency sufficient to determine trends and if water quality standards are being met.

2.6.2 Comparability

TDG and temperature were monitored using standard units of measurement at fixed locations, and therefore data are comparable to data collected historically by Chelan PUD.

2.6.3 Completeness

TDG

Data collection, QA/QC, and analyses of TDG values were conducted in accordance with the QAPP for the FMS (Chelan PUD, 2010). For this report, hourly TDG data recorded during 2014 were analyzed for apparent exceedances of current water quality standards.

All of the TDG sensors used during 2014 were calibrated and maintained in accordance with the methods and schedules described in the QAPP (Chelan PUD, 2010). TDG sensors that did not pass calibration tests were sent back to the manufacture for repair and/or replaced prior to deployment. Calibration reports are included in Appendix B of this report. Suspect or clearly erroneous TDG values were omitted from the analysis, but are included, as well as explanation for omission, in Appendix C of this report.

The data QA/QC issues during the 2014 were related to either TDG probe communication. Overall data loss for Chelan PUD operated FMS during the 2014 fish-spill season were 387 hourly readings (3.5 percent of the total available data collection hours). Chelan PUD attributed these data lost to aging probes, and therefore replaced all FMS TDG probes on June 18, 2014.

Overall data loss for the FMS during the 2014 non fish spill season were 92 hourly readings (0.48 percent of the total available data collection hours).

Table 2-1 and Table 2-2 display the number of TDG values that were omitted from the dataset due to QA/QC issues during the 2014 fish-spill and non fish spill season respectively.

Table 2-1: Overview of total dissolved gas data set during 2014 fish spill season.

Location	Available data collection hours	Number of omitted/ lost hourly readings[1]	Percent data loss (%)
RRFB FMS	3,672	4	0.1%
RRTR FMS	3,672	3	0.1%
RIFB FMS	3,672	380	10.3%
Total	**11,016**	**387**	**3.5%**

Note: RRFB = Rocky Reach Forebay, RRTR = Rocky Reach Tailrace, RIFB = Rock Island Forebay

[1]See Appendix C for dates, times, and circumstances relating to omitted/lost data.

Table 2-2: Overview of total dissolved gas data set during 2014 non fish spill season January 1 through March 31 and September 1 through December 31.

Location	Available data hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
RRFB	4,704	18	0.4
RRTR	4,704	18	0.4
RIFB	4,704	56	1.2
Total	**18,816**	**92**	**0.48**

Notes: RRFB = Rocky Reach Forebay, RRTR = Rocky Reach Tailrace, RIFB = Rock Island Forebay
[1]See Appendix C for dates, times, and circumstances relating to omitted/lost data.

Temperature at Rocky Reach Forebay and Tailrace

Data collection, QA/QC, and analyses of water temperature followed those described in the QAPP (Chelan PUD, 2010). Table 2-2 shows the number of values that were omitted from the dataset due to QA/QC issues compared to the total number of available hours. Overall data loss in the 2014 monitoring season was 31 hours of the combined 10,272 available hours, which was within the 90 percent data completeness decision quality objective as specified in the QAPP.

Table 2-3: Overview of temperature data set during the 2014 monitoring period (April 1 through October 31).

Location	Available data collection hours	Number of omitted/ lost hourly readings	Percent data completeness (%)
RRFB FMS	5,136	4	99.9
RRTR FMS	5,136	3	99.9
Total	**10,272**	**31**	**99.7**

Note: RRFB = Rocky Reach Forebay, RRTR = Rocky Reach Tailrace

2.6.4 Precision

The TDG and temperature monitoring program implemented in 2014 used the same type of equipment to monitor water quality over a small spatial and temporal regime at all sites. Additionally, duplicate sampling occurred during monthly calibrations. See Appendix B for the calibration reports.

2.6.5 Bias

Bias was minimized by following standard protocols for calibration and maintenance.

As discussed in the QAPP (Chelan PUD, 2010), the accuracy/bias of the FMS temperature sensors is ±0.1°C. During 28 instrument maintenance/calibrations, instrument temperature was compared to a standard. Of these 28 comparisons, 26 met the data quality objective of ±0.1°C (Appendix B). The two remaining comparisons (±0.2 and ±0.3°C) did not meet the measurement data quality objective (MQO) as discussed in the QAPP; however the criteria may be overly strict and may need to be revised. Since completion of the QAPP, Chelan PUD has received input from Ecology that it is not recommended to use the instrument's manufacturer specification for MQOs because expected instrument error alone can cause a failure of meeting the QA/QC criteria. With this recommendation in mind, Chelan PUD has determined that the data from these instruments appear acceptable for use.

2.6.6 Sensitivity

All of the sensors used for the monitoring program have accuracy/bias that are better than required to determine compliance with water quality standards.

2.6.7 Calibration and Maintenance

Forebay and Tailrace TDG and Temperature

Section 5.7.3 of the 401 Certification requires Chelan PUD to maintain a TDG monitoring program that is at least as stringent as the QA/QC calibration and monitoring procedures and protocols developed by the United States Geological Survey (USGS) monitoring methodology for the Columbia River.

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as HydroLab Inc.'s recommendations. These QA/QC protocols are included in Chelan PUD's Ecology/FERC approved QAPP (Appendix A).

Chelan PUD entered into a Professional Services Agreement with Columbia Basin Environmental to perform monthly calibrations and equipment maintenance on the forebay and tailrace TDG/temperature instruments. QA/QC measures were accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log was maintained for all work done on the monitoring equipment, including monthly maintenance, calibration, exchange of instruments, and any other pertinent information. Redundant measurements with a mobile instrument to verify the accuracy of the in-situ instruments were conducted during the monthly calibrations. Calibration reports are included as Appendix B of this report and in the 2014 Annual Gas Abatement Report (Appendix E).

GBT

Per Section 5.4(1)(c) of the 401 Certification, Chelan PUD shall conduct a one-time study of GBT. However, in a draft letter received by Chelan PUD on April 21, 2014, Ecology recommended Chelan PUD postpone any gas bubble trauma study on native fish and/or invertebrates until such time as it may be determined to be necessary. Ecology is currently evaluating the need for future GBT studies.

SECTION 3: ***RESULTS AND DISCUSSION***

3.1 TDG

Please refer to the 2014 Gas Abatement Annual Report (Appendix D) for detailed information regarding TDG during the fish spill season (April 1 through August 31).

Between January 1 and March 31, 2014, the non fish spill criterion of 110 percent was exceeded seven hours in the Rocky Reach tailrace, but not for any hours in the Rock Island forebay, resulting in 99.9 percent and 100 percent of the hours meeting TDG criteria, respectively.

Between September 1 and December 31, 2014, the non fish spill criterion of 110 percent was not exceeded for any hours in the Rocky Reach tailrace or Rock Island forebay, resulting in 100 percent compliance of the hours meeting TDG criteria.

3.1.1 Alternative Spillway Operations

Under Section 5.4.1(b)(6) of the 401 Certification, Chelan PUD is required to implement alternative spillway operations, using any of gates 2 through 12, to determine, in consultation with the RRFF and HCP CC, whether TDG levels can be reduced without adverse effects on fish passage. If effective in reducing TDG and not adversely affecting fish passage, Chelan PUD will implement the alternative.

Chelan PUD has identified four steps or phases necessary in order to complete the condition 5.4.1(b)(6). The identified phases are listed and discussed further below.

Phase 1. Develop and run test scenarios for spill gate configurations, collect data

Phase 2. Analyze the data collected during the test scenarios for TDG reduction

Phase 3. Further analyze the TDG reductions and potential effects on fish passage

Phase 4. If effective in TDG reduction without potentially affecting fish passage, develop an implementation plan in coordination and consultation internally with Chelan PUD operations and externally with the RRFF and the HCP CC

Phase 1. Develop and run test scenarios for spill gate configurations, collect data

Alternative spillway flow distribution patterns were studied in 2011 and 2012 in order to evaluate the potential to reduce TDG levels, particularly during high spill levels (above 50 kcfs). The standard spillway flow pattern, which has been in use for over 20 years, is designed to create a V-shaped pattern of high velocity, aerated water below the spillway that is presumed to lead upstream migrating adult salmon toward the vicinity of the entrances to the upstream passage fishways. However, the margins of the V-shaped pattern tend to distort at spillway flows above 50 kcfs and appear to have less value for enhancing fish guidance to the fishway entrances. The standard spillway pattern confines spill to 7 gates (gates 2 through 8), leaving gates 9 through 12 unused. Studies of TDG levels at other Columbia River basin hydroelectric projects have shown that TDG levels are typically reduced when spillway flows are spread between more gates, thus reducing the flow per gate. The studies in 2011 and 2012 were planned to test three alternative spill patterns during normal operations to see if TDG levels would be reduced by any of these alternate patterns.

Phase 2. Analyze the data collected during the test scenarios for TDG reduction

The results of the 2011 and 2012 studies (Chelan PUD, 2013) were analyzed from the perspective of absolute TDG levels under different spillway flow volumes and the percentage of increase or decrease in TDG levels in the tailrace below the spillway, compared to the ambient TDG arriving at the Rocky Reach Project's forebay. Generally, all of the three alternative spill patterns resulted in lower TDG levels than the standard spill pattern. Of the three alternative patterns, the flat spill pattern (flow distributed evenly between spillway gates) had a slightly better TDG performance than the other two alternative patterns, which attempted to maintain some semblance of the V-shaped turbulence zone desired for adult salmon guidance. The Parametrix (Chelan PUD, 2013) analysis did not explore whether there was any disruption of fish passage associated with the use of the alternative spill patterns. Also, since both 2011 and 2012 were high flow years, most of the time the spillway flow was greater than 50 kcfs during these tests, thus any effects on fish passage might have been masked due to the overall effects of high spill, regardless of the spill pattern in use. The standard spill pattern is a required operating procedure for upstream salmon passage, thus prior to changing that pattern for the purpose of reducing TDG an analysis of effects on fish passage is needed. Any decision to permanently change the spill pattern would require approval by the RRFF and HCP CC.

Phase 3. Further analyze the TDG reductions and their potential affect on fish passage

Chelan PUD has conducted some further analysis of the 2011 and 2012 spill and TDG data to determine if there is sufficient potential benefit regarding TDG levels to warrant changing the spill pattern for spill volumes of 50 kcfs or less. Chelan PUD began by looking only at the 2011 data set, as this year was more consistent in the duration and frequency of the test of the flattened spill configuration. In addition, the adult salmon passage data for Chinook and sockeye were examined to determine if there were any apparent adverse effects on daily passage rates during the 2011 study. This analysis indicates that there may be a significant reduction in TDG levels for spillway volumes of 40 kcfs or greater if the flat spill pattern were used rather than the standard spill pattern. There were not sufficient data to determine if the flat spill pattern would significantly reduce TDG for spill levels of less than 40 kcfs. This is, for the most part, consistent with the findings of a previous study (Schneider and Wilhelms, 2005) which found little difference in TDG levels generated with either the standard spill pattern or with spill spread evenly between spillway gates 2 through 12 (roughly equivalent to the flat spill pattern tested in 2011). However, the Schneider and Wilhelms study had very limited data for spill levels above 40 kcfs and no data for spill volumes greater than 60 kcfs. Thus, the ability to detect a reduction in TDG levels using the flat spill pattern was limited during this study.

Chelan PUD grouped the 2011 spill and TDG data for the standard spill pattern (FISH) and the flat spill pattern (FLAT) into increments of spillway flow bands of 10 kcfs. For example, all data for spillway flows greater than or equal to 40 kcfs, but less than 50 kcfs, were analyzed for the standard and flat spill patterns. The TDG data during these spill levels were averaged over 10 minute intervals and the percent TDG saturation was plotted for each ten minute average. The forebay TDG level was also averaged over the same interval and plotted. The graphs for the 40 kcfs – 50 kcfs and 50 kcfs – 60 kcfs spill levels are shown in Figures 3-1 and 3-2. These plots of 10 minute intervals indicate that the flat spill pattern may reduce TDG levels slightly compared to the standard spill pattern. However, the plots also show a correlation between TDG levels measured at the tailrace monitoring location and TDG levels measured in the forebay. In theory, if the tailrace monitoring location is only measuring TDG from water that passed through the spillway, as opposed to a mixture of water from both the spillway and the powerhouse, the TDG level in spillway flows should be independent from the forebay TDG level. Since this was not the case, the flow passing by the tailrace monitoring location must be receiving a mixture of powerhouse flows and spillway flows. Since forebay TDG was not consistent for the different time periods when the standard and flat spill patterns were being used, the data could not definitively demonstrate that the flat spill pattern reduced TDG levels over the standard spill pattern. In order to determine whether the flat

spill pattern indeed reduces TDG, that pattern would need to be observed over a longer time period than under the daily change in spill pattern that was used during the 2011 and 2012 studies.

The use of different spill patterns did not appear to have any adverse effect on adult salmon passage at the Rocky Reach Project. The two species of salmon with peak migrations during the study were Chinook salmon and sockeye salmon. Plots of daily passage counts for these two species did not demonstrate any apparent delays or failures to find the fishway entrances. The daily passage counts of Chinook and sockeye salmon, with the spill pattern in effect each day, are shown in Figures 3-3 and Figure 3-4. Further study of the flat spill pattern, particularly for spill flows less than 50kcfs where the standard pattern creates a well defined V-shaped pattern, would be needed to evaluate whether adult salmon passage is adversely affected by use of the flat spill pattern.

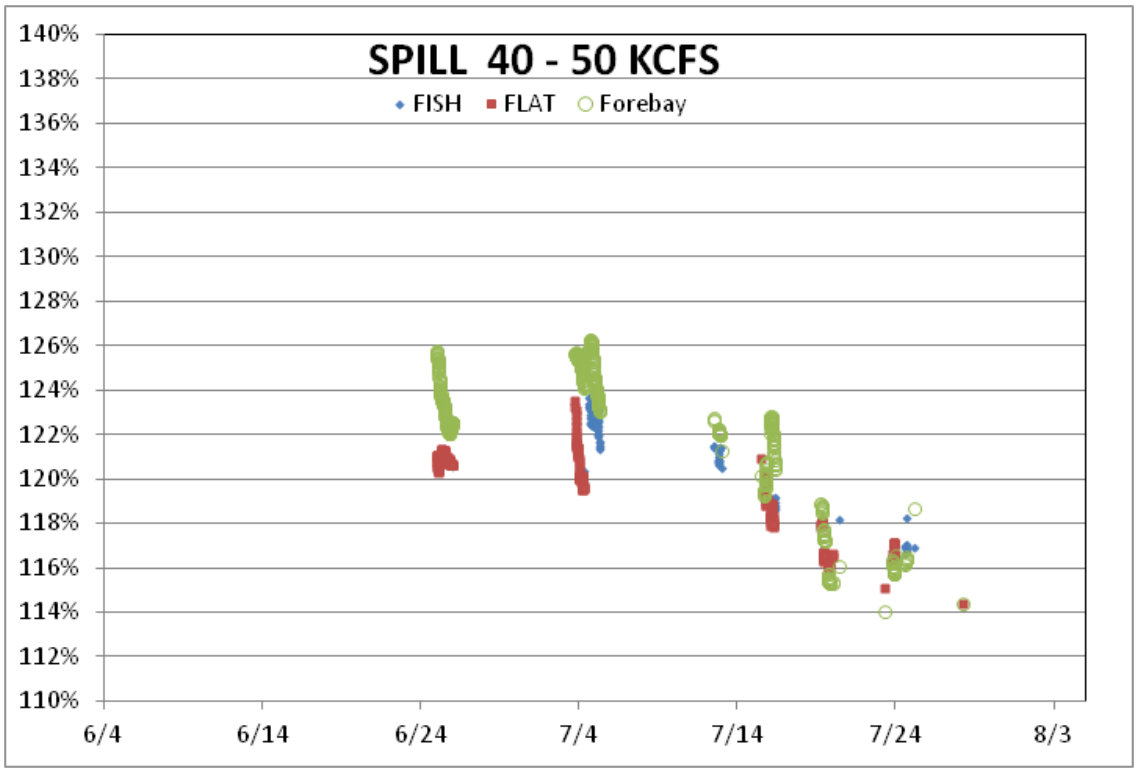

Figure 3-1: TDG levels at the Rocky Reach tailrace monitoring station for spillway flows from 40- 50 kcfs.

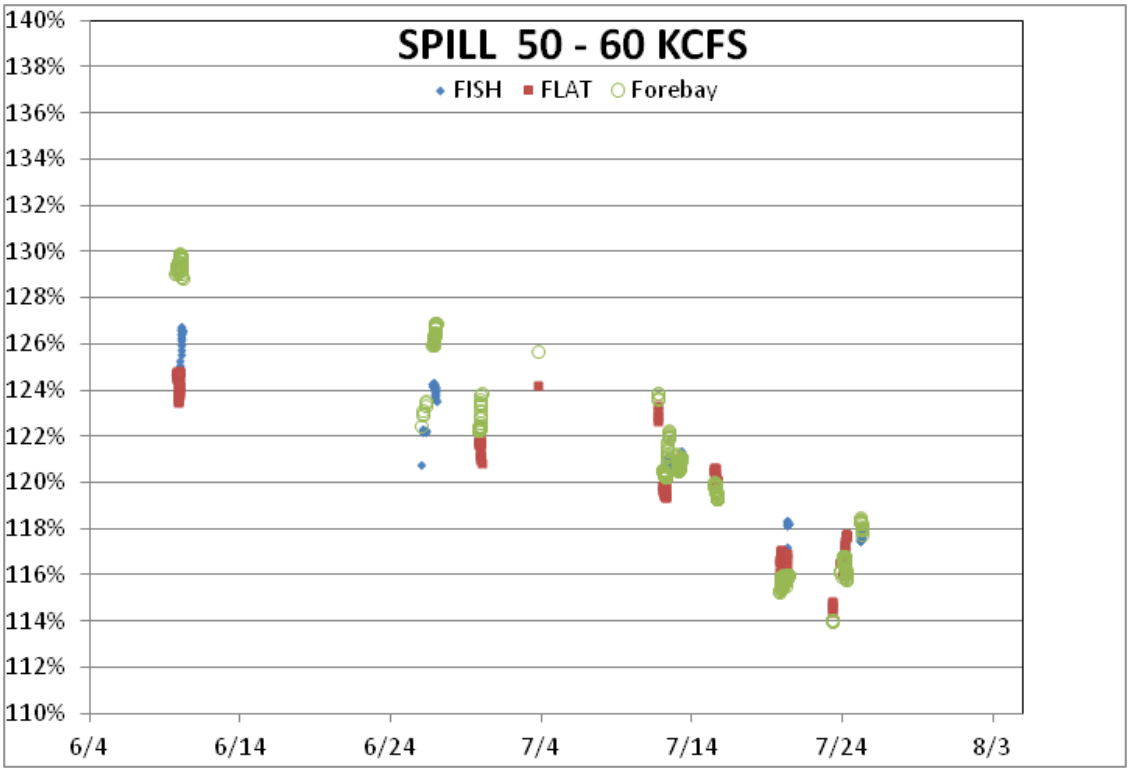

Figure 3-2: TDG levels at the Rocky Reach tailrace monitoring station for spillway flows from 50- 60 kcfs.

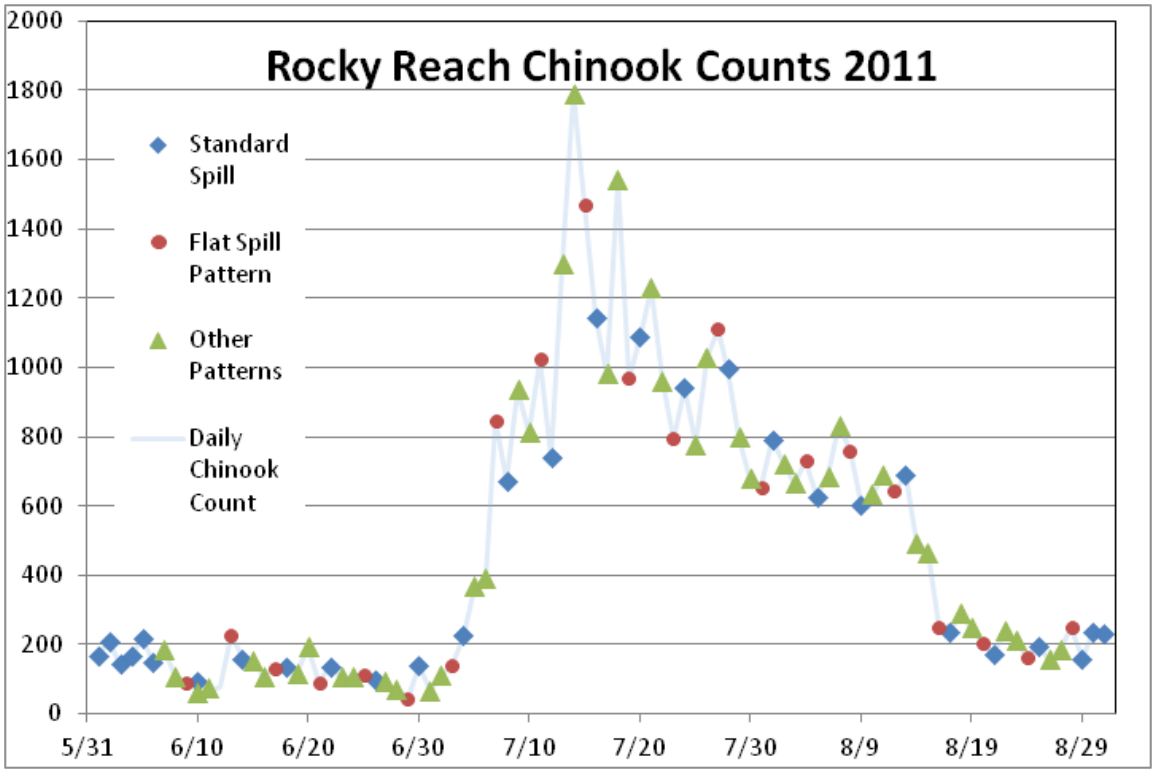

Figure 3-3: Daily passage counts of Chinook salmon at Rocky Reach, with spill pattern in effect that day.

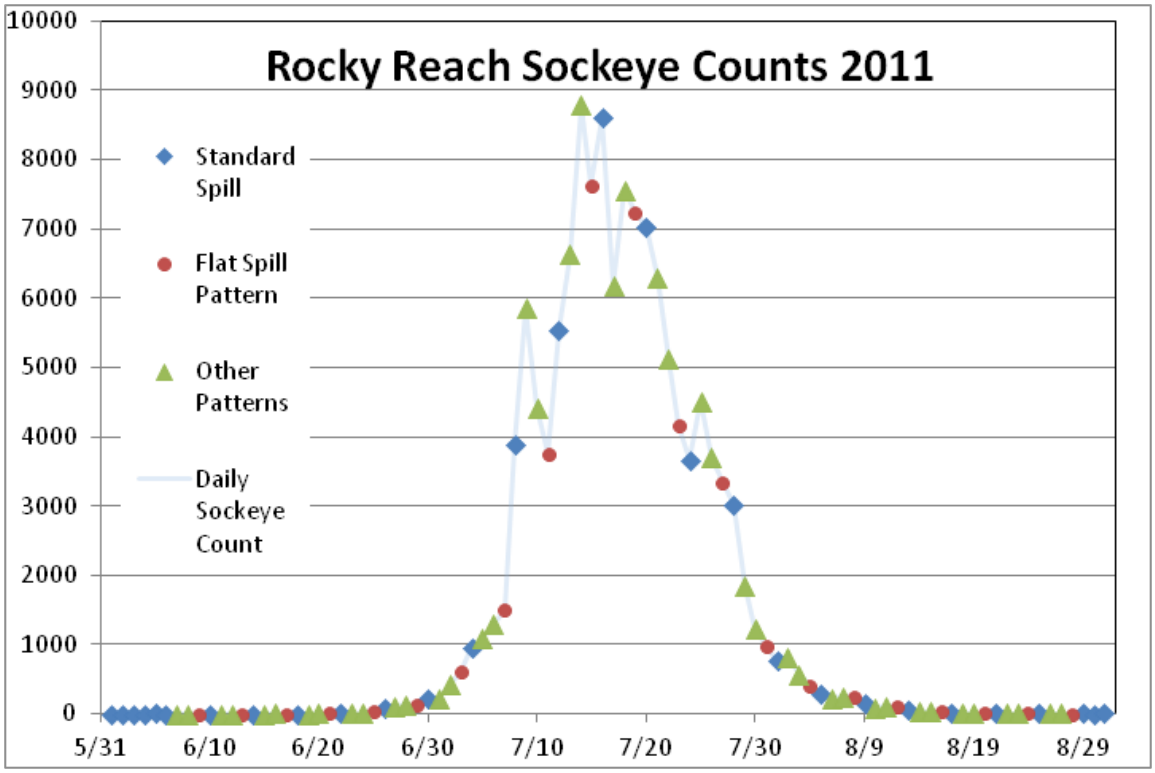

Figure 3-4: Daily passage counts of sockeye salmon at Rocky Reach, with spill pattern in effect that day.

Phase 4. If effective in TDG reduction without potentially affecting fish passage, develop an implementation plan in coordination with various parties

Chelan PUD has presented our findings with the RRFF and HCP CC. Through the consultation process, the RRFF and HCP CC shall determine if the Flattened Spill configuration will be implemented. If implementation is decided upon, then Chelan PUD will develop a schedule to make the necessary changes to perform the new spill configuration. This schedule may include, but is not be limited to computer automation of spill gates, changes to system operations, and monitoring. Chelan PUD will operate the new spill configuration as a pilot or test spill and further evaluate the results for a designated period of time. If upon operating under the new spill configuration, data show that optimal results are not occurring as previously evaluated, Chelan PUD will implement adaptive management in coordination with the RRFF and HCP CC.

3.2 Temperature

State of Washington's Water Quality Standards designate a temperature criterion for the Project area of 17.5°C, except when a water body's temperature is warmer than 17.5°C and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. For the purposes of this report, "natural condition" is the background/incoming condition (i.e. Wells tailrace for the Rocky Reach forebay, and the juvenile fish bypass entrance for the sampling facility). Compliance, for the purpose of this report, was calculated by first determining if the7-DADMax temperature of 17.5°C was exceeded at each monitoring location. If temperatures exceeded 17.5°C, at the Rocky Reach forebay or Rocky Reach tailrace, those temperatures were compared to the "background" temperatures in the Wells tailrace and Rocky Reach forebay, respectively.

3.2.1 Forebay, Tailrace, and Wells Dam tailrace

Daily maximum temperatures from the three sites were used to determine the 7-DADMax. Figures 3-5 and 3-2 present graphical displays of the 1-DMax and 7-DADMax values (Appendix D). In general, water temperatures peaked during the months of July through September. Table 3-1 below summarizes the number of exceedances of the 7-DADMax criteria and percent days criterion were met for each monitoring site.

Section 5.5(1)(c) of the 401 Certification, states these data will be used to run the CE-QUAL-W2 model in Year 5 of the License to evaluate the Project compliance with numeric temperature criteria. However, in a draft letter received by Chelan PUD on April 21, 2014, Ecology recommended that modeling temperature in the Rocky Reach pool be postponed until such time as it may be recommended by Ecology. It is hoped that these data and/or modeling effort may be coordinated regionally.

Table 3-1: Summary of days meeting temperature criterion in the Rocky Reach forebay, Rocky Reach tailrace, and Wells tailrace, 2014.

Location	Data Collection Period	# of Exceedances[1]	% of Days that Criterion was Met
Wells Tailrace	4/1—10/31	84[2]	
Rocky Reach Forebay	4/1—10/31	85	60.3%
Rocky Reach Tailrace	4/1—10/1	84	60.7%

[1]State of Washington's Water Quality Standards designate a temperature criterion for the Project area of 17.5°C, except when a water body's temperature is warmer than 17.5°C and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. For the purposes of this report, "natural condition" is the background/incoming condition (i.e. Wells tailrace for the Rocky Reach forebay, and the Rocky Reach forebay for the Rocky Reach tailrace.

[2]Wells tailrace "exceedance" is simply an exceedance of the 17.5° criterion. It does not take into account the "natural conditions" in the Wells forebay.

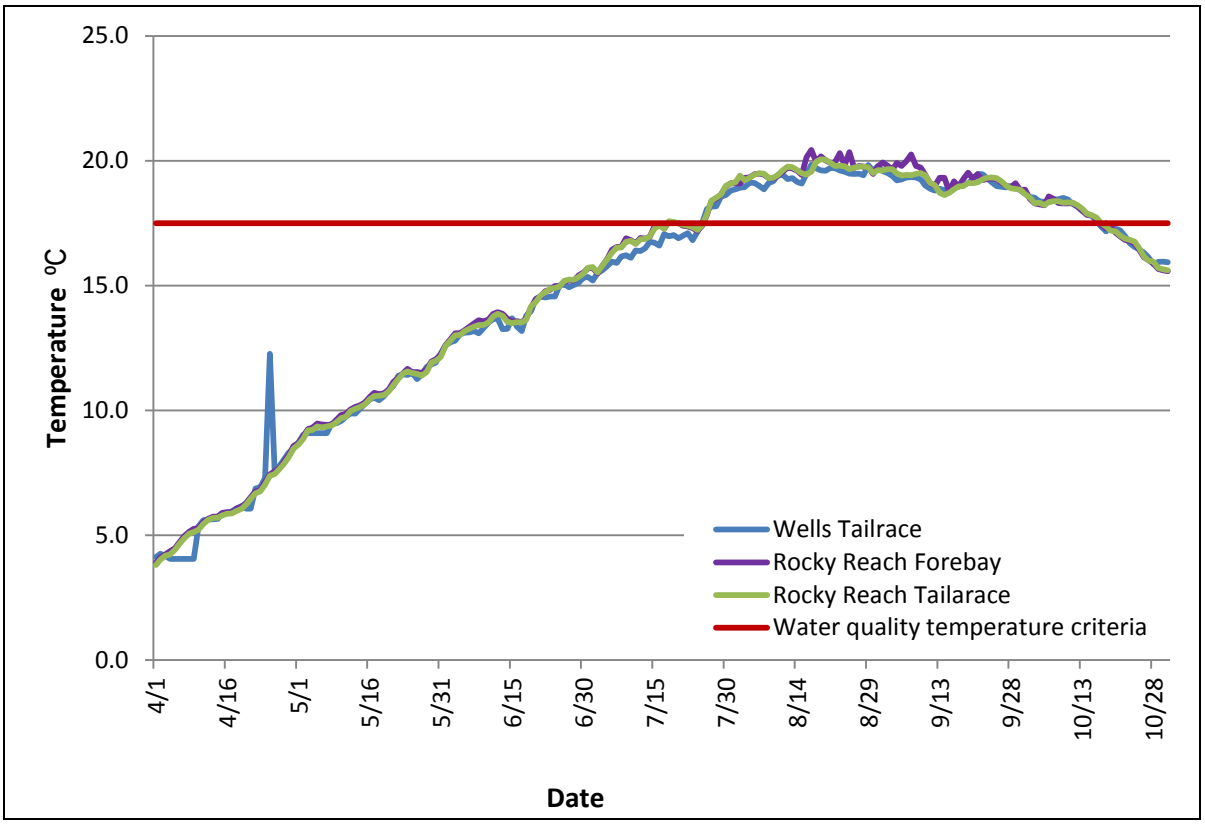

Figure 3-5: Daily maximum water temperature values recorded at each site in 2014.

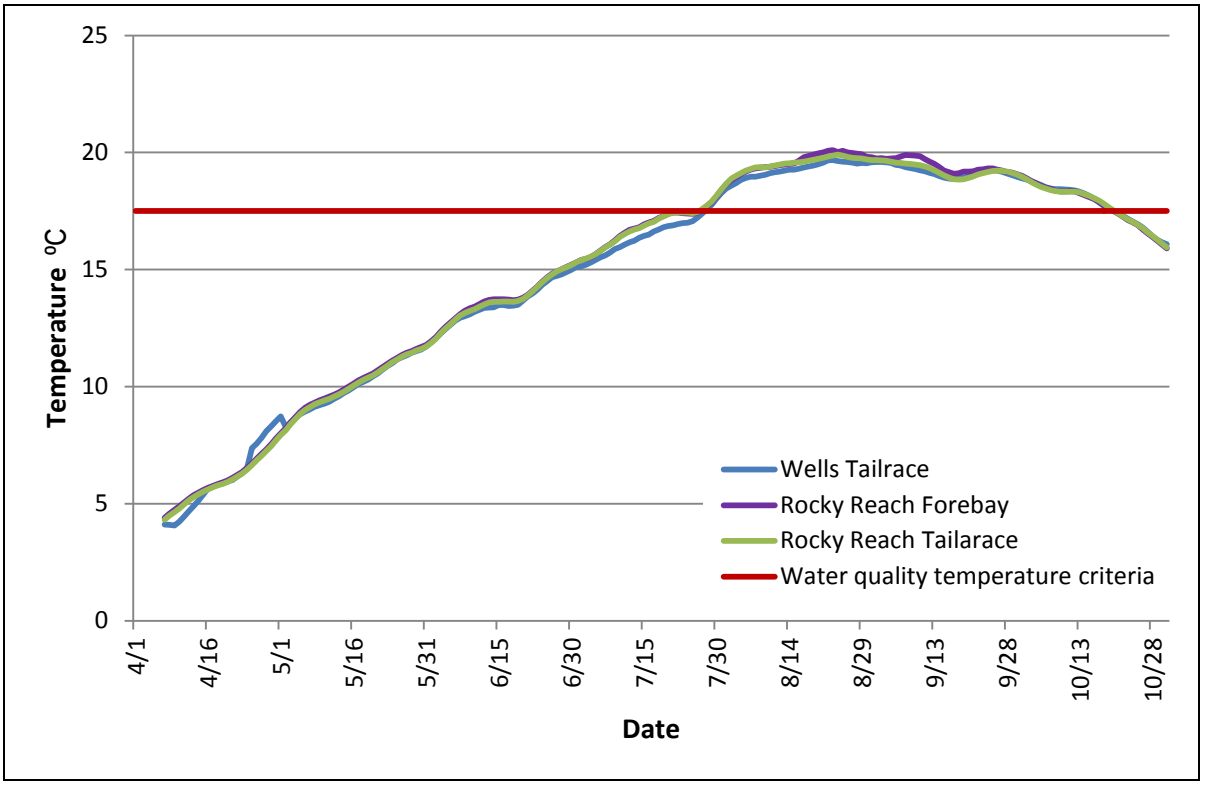

Figure 3-6: Seven day rolling average of daily maximum temperature values recorded at each site in 2014.

3.2.2 Upstream Fishway Water Temperature Analysis

The water temperature data recorded in the Upstream Fishway as described in Section 2.2, along with the data recorded in the forebay FMS were evaluated along different routes. First, the data from within the fishway (upper and lower thermisters) were examined for measureable differences. There was no measurable difference in the temperature readings of T3 and T4, and T5 and T6. With no measureable differences in the upper and lower thermister's (T3-T4 and T5-T6), data from the thermisters placed five feet off the floor were used in the summary statistics and 7-day averages represented in Tables 3-2 through 3-4. Second, the data from within the fishway (Exit, Mid, and 90º) were examined for longitudinal and temporal trends. Finally, the water temperature in the fishway data were compared to water temperature data in the forebay.

Tables 3-2 through 3-4 and Figures 3-7 display the relevant information for the summary results.

It is important to note as stated in the QAPP (Chelan PUD, 2010) that the manufacturer's stated accuracy of the thermistors used for monitoring the water temperature of the Upstream Fishway is ±0.2°C.

Upstream Fishway Water Temperatures

Minimum, maximum, and average daily temperatures were similar within the Rocky Reach Upstream Fishway recorded during the study period. Mean water temperatures varied from 3.6 to 10.5°C during the months of March through May; peaked during September (19.1 to 19.2°C) and then decreased during the remainder of the study period with an approximate average of 17.3°C during October. The highest temperatures were recorded in September. Maximum temperatures reached, or exceeded 20°C in the Upstream Fishway during September. Additionally, the 7-DADMax exceeded 17.5°C during all of August and September, for some days during July and 19 days in October (Table 3-2).

Upstream Fishway Longitudinal and Temporal Analysis

Table 3-3 displays the temperature differences, based on daily averages within the Upstream Fishway. There were no measurable differences of the minimum, max, mean or standard deviation of compared water temperatures within the Upstream Fishway. Figure 3-7 compares the daily average water temperature ºC differences within the Upstream Fishway at three sample locations (Exit, Mid, 90º) at Rocky Reach Dam. Although the accuracy of the thermisters is ±0.2°C, the plotted data in Figure 3-7, show a slight (0.1ºC) cooling from the Mid to the 90º and the Exit to the 90º locations.

Comparison to FMS Data

Tables 3-3 and 3-4 compare the Upstream Fishway to the forebay FMS and summarize the data for the forebay FMS, respectively. In analyzing the data, there was little difference in the daily average temperatures of the forebay compared to the Exit, and the forebay compared to the 90º locations. On May 18, 2014 the max temperature recorded in the forebay was 0.6°C cooler than the Upstream Fishway with the minimum temperature differences in the forebay vs. the Upstream Fishway varying ±0.1°C.

Table 3-2: Summary statistics and 7-day average of the daily maximum temperatures (7-DADMax) for the Onset® HOBO® Water Temp Pro v2 temperature data collected at the Upstream Fishway at Rocky Reach Dam, during 2014.

Temperature in °C							7-DADMax	
Location	Month	Total Obs	Min	Max	Mean	Std Dev.	# greater than 17.5	Total #
Exit (T2)	March	17	3.3	4.0	3.6	0.1	0	17
	April	30	3.9	8.7	6.0	1.2	0	30
	May	31	8.4	12.4	10.5	1.0	0	31
	Jun	30	12.3	15.5	14.0	0.8	0	30
	Jul	31	15.3	19.1	17.0	0.9	4	31
	Aug	31	18.8	20.1	19.5	0.3	31	31
	Sep	30	18.5	19.8	19.1	0.3	30	30
	Oct	18	15.4	18.7	17.3	1.0	19	18
	Nov	30	10.2	15.5	13.3	1.5	0	30
	Dec	31	5.4	10.2	8.2	1.2	0	31
	Jan	4	5.1	5.4	5.2	0.1	0	4
Mid (T4)	March	17	3.2	3.9	3.6	0.1	0	17
	April	30	3.9	8.7	6.0	1.2	0	30
	May	31	8.4	12.4	10.5	1.0	0	31
	Jun	30	12.3	15.5	14.0	0.8	0	30
	Jul	31	15.3	19.2	17.0	0.9	5	31
	Aug	31	18.8	20.1	19.5	0.3	31	31
	Sep	30	18.6	19.9	19.2	0.3	30	30
	Oct	31	15.4	18.7	17.3	1.0	19	18
	Nov	30	10.2	15.5	13.3	1.5	0	30
	Dec	31	5.4	10.2	8.2	1.2	0	31
	Jan	4	5.1	5.4	5.2	0.1	0	4
90 degree Pool (T6)	March	17	3.2	3.9	3.6	0.1	0	17
	April	30	3.8	8.7	6.0	1.2	0	30
	May	31	8.4	12.4	10.5	1.0	0	31
	Jun	30	12.2	15.6	14.0	0.8	0	30
	Jul	31	15.3	19.2	17.0	0.9	4	31
	Aug	31	18.8	20.1	19.5	0.3	31	31
	Sep	30	18.5	19.8	19.1	0.3	30	30
	Oct	31	15.3	18.7	17.3	1.0	19	18
	Nov	30	10.1	15.5	13.2	1.5	0	30
	Dec	31	5.3	10.1	8.2	1.2	0	31
	Jan	4	5.1	5.3	5.2	0.1	0	4

Table 3-3: Temperature difference (based on daily averages) within fishway (Exit vs. Mid, Mid vs. 90º, and Exit vs. 90º), and between the Upstream Fishway and the FMS forebay station at Rocky Reach dam, during 2014.

Comparison	Temperature				
		Min	Max	Mean	Std. Dev.
Fishway	Exit → Mid	0.0	0.0	0.0	0.0
	Mid → 90º	-0.1	0.0	0.0	0.0
	Exit → 90º	-0.1	0.0	0.0	0.0
Fishway vs. Forebay FSM	Exit → FB	-0.1	0.6	0.0	0.1
	FB → 90º	-0.1	0.6	0.0	0.1

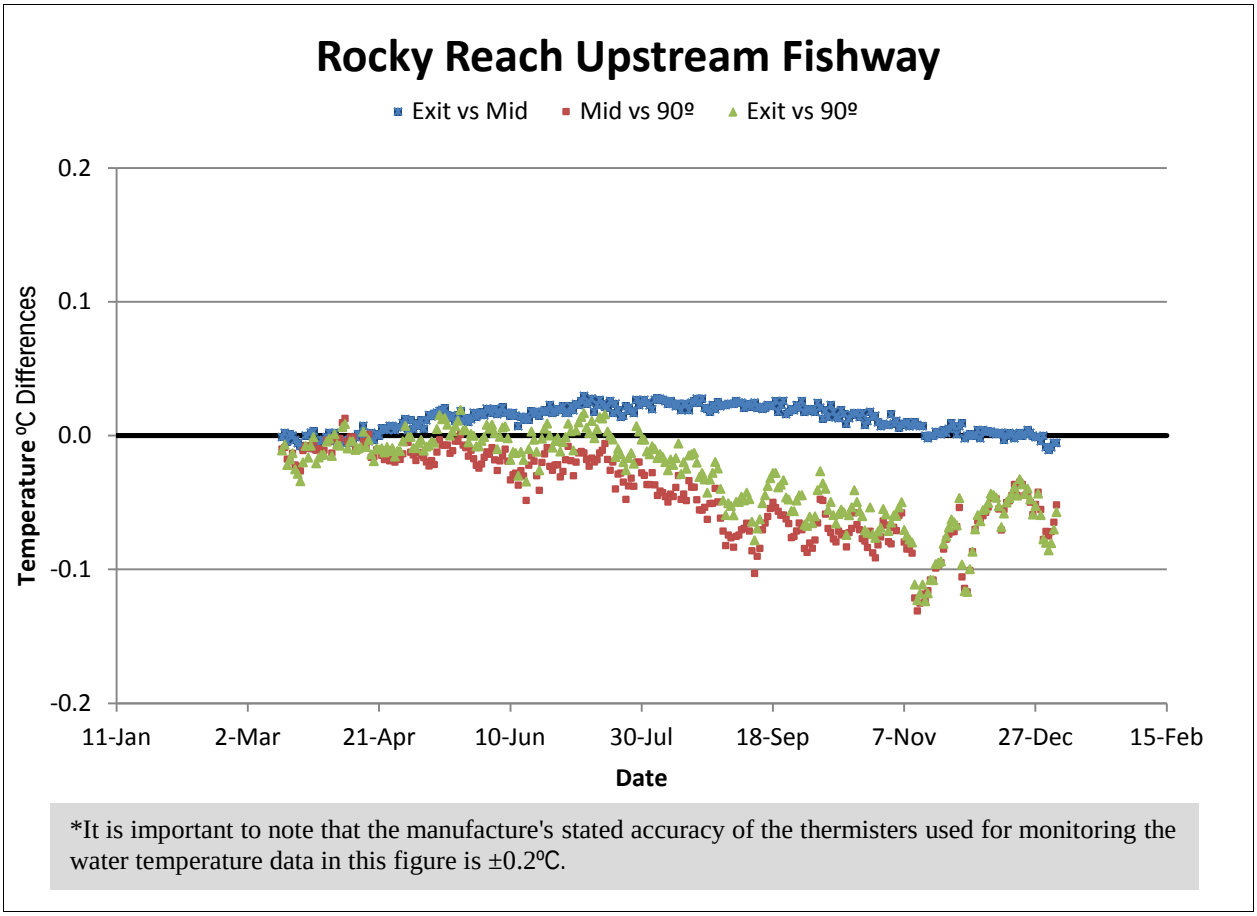

Figure 3-7: Comparison of daily average water temperature ºC differences within the Upstream Fishway at three sample location (Exit, Mid, 90º) at Rocky Reach Dam

Table 3-4: Summary statistics and 7-day average of the daily maximum temperatures (7-DADMax) for the Rocky Reach dam forebay FMS, during 2014.

			Temperature in °C				7-DADMax	
Location	Month	Total Obs.	Min	Max	Mean	Std. Dev.	# greater than 17.5ºC	Total#
FB	March	17	3.3	3.7	3.5	0.1	0	17
	April	30	3.8	8.3	5.9	1.2	0	30
	May	31	8.5	12.2	10.4	1.0	0	31
	June	30	12.4	15.4	13.9	0.9	0	30
	July	31	15.5	18.9	17.0	0.9	5	31
	Aug	31	18.9	20.0	19.5	0.3	31	31
	Sep	30	18.6	19.6	19.1	0.3	30	30
	Oct	18	15.5	18.6	17.3	1.0	15	18
	Nov	30	10.6	15.5	13.3	1.5	0	30
	Dec	31	5.7	10.0	8.3	1.2	0	31
	Jan	4	5.2	5.3	5.3	0.0	0	4
FB= Rocky Reach Forebay, Obs.=observations								

3.3 JBS Entrance and Sampling Facility

Because the required one year of data were collected in 2012, no temperature data were collected in the JBS Entrance or Sampling Facility in 2014.

3.4 GBT

Per Section 5.4(1)(c) of the 401 Certification, Chelan PUD shall conduct a one-time study of GBT. However, in a draft letter received by Chelan PUD on April 21, 2014, Ecology recommended Chelan PUD postpone any gas bubble trauma study on native fish and/or invertebrates until such time as it may be determined to be necessary. Ecology is currently evaluating the need for future GBT studies.

3.5 Shallow Water Habitat Dissolved Oxygen, pH and Water Temperature

Shallow water habitats in the reservoir, including macrophyte beds, were monitored for compliance with numeric criteria for dissolved oxygen, pH and water temperature during August and September of 2012 and reported in the 2013 Rocky Reach Annual Water Quality Monitoring Report.

SECTION 4: ***PROPOSED 2015 ACTION PLAN***

4.1 TDG

Chelan PUD plans to continue the TDG monitoring program as conducted in 2014 for the 2015 monitoring season.

4.2 Temperature

4.2.1 Forebay and Tailrace

Chelan PUD plans to continue the forebay and tailrace temperature monitoring program conducted in 2014 for the 2015 monitoring season.

4.2.2 Upstream Fishway and Juvenile Bypass System

As the one year of required temperature monitoring was conducted in the JBS in 2012, and the fishway in 2014, Chelan PUD does not plan to monitor temperature in the JBS or fishway in 2015.

4.3 GBT

Per Section 5.4(1)(c) of the 401 Certification, Chelan PUD shall conduct a one-time study of GBT. However, in a draft letter received by Chelan PUD on April 21, 2014, Ecology recommended Chelan PUD postpone any gas bubble trauma study on native fish and/or invertebrates until such time as it may be determined to be necessary. Ecology is currently evaluating the need for future GBT studies.

SECTION 5: ***PROPOSED CHANGES TO QAPP***

Chelan PUD does not propose any changes to the current Ecology/FERC approved QAPP (Chelan PUD, 2010) at this time. The QAPP can be found on Chelan PUD's website at http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf as referenced in Appendix A.

SECTION 6: ***LIST OF LITERATURE***

Chelan PUD. 2010. Quality Assurance Project Plan Rocky Reach Water Quality Monitoring and Reporting. Chelan PUD. Wenatchee, WA.

Chelan PUD. 2012. Quality Assurance Project Plan Update for Shallow Water/Macrophyte Bed Sampling. Chelan PUD. Wenatchee, WA.

Chelan PUD. 2013. Spill Data Evaluation Rocky Reach Dam 2011-2012. Prepared by Weitkamp, D.E. and Sullivan B.D, Parametrix, for Chelan PUD. Wenatchee, WA.

Schneider, Michael L. and Steven C. Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. U.S. Army Engineer Research and Development Center, Vicksburg.

Washington State Department of Ecology (Ecology). 2006. Water Quality Certification for the Rocky Reach Project. Order No. 3155 dated March 17, 2006. http://www.chelanpud.org/documents/RR_Section_401_Water_Quality_Cert.pdf

Washington State Department of Ecology. 2014. Letter to Chelan PUD from Charlie McKinney postponing a one-time GBT study and the CE-QUAL-W2 temperature model. April 21, 2014.

APPENDIX A: FINAL QUALITY ASSURANCE PROJECT PLAN

The final Quality Assurance Project Plan can be found at the following link:

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf

APPENDIX B: CALIBRATION REPORTS

APPENDIX C: DATA LOSSES AND OMISSIONS

APPENDIX D: DAILY MAXIMUM TEMPERATURE AND 7-DAY ROLLING AVERAGE OF THE DAILY MAXIMUM TEMPERATURES

APPENDIX E: 2014 ANNUAL GAS ABATEMENT REPORT

The final 2014 Annual Gas Abatement Report can be found at the following link:

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/43948.pdf

APPENDIX F: SPILL DATA EVALUATION ROCKY REACH DAM 2011-2012

The Spill Data Evaluation for Rocky Reach Dam 2011-2012 can be found at the following link:

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/42306.pdf

APPENDIX G: CONSULTATION RECORD

Ecology Comment	Chelan PUD Response