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Subject:	For Review - Draft Lake Chelan Annual Flow and Water Temperature Report 2014
Date:	Monday, March 16, 2015 1:16:11 PM
Attachments:	2014 Annual Flow and Temperature Report - Final Draft 03162015.pdf 2014 Annual Flow and Temperature Report - Final Draft 03162015.docx

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P U B L I C U T I L I T Y D I S T R I C T N O . 1 o f C H E L A N C O U N T Y

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To: Chelan River Fishery Forum

Washington Department of Ecology

Washington Department of Fish and Wildlife

United States Forest Service

National Park Service

United States Fish and Wildlife Service

National Marine Fisheries Service

CCT (Colville)

YN (Yakama)

CTUIR (Umatilla tribe)

City of Chelan

Lake Chelan Sportsman Association

United States Geological Survey

Washington State Parks and Recreation Commission

Washington State Recreation and Conservation Office

Manson Parks and Recreation Department

Lake Chelan Recreation Association

American Whitewater

From: Steven Hays, Fish & Wildlife Senior Advisor

Public Utility District No. 1 of Chelan County (Chelan PUD)

steve.hays@chelanpud.org

(509)661-4181

Re: Lake Chelan Hydroelectric Project No. 637 (Project)

License Articles 405a and 408; Appendix D 401 Water Quality Certification Condition V.C.i)

Draft Lake Chelan Annual Flow and Water Temperature Report 2014

Dear Chelan River Fishery Forum and Other Parties:

In accordance with Articles 405 and 408 of the Lake Chelan Hydroelectric Project License, Chelan PUD invites comments on the Draft Lake Chelan Annual Flow and Water Temperature Report 2014 (attached).

Please submit your comment letters on or before 3:00 p.m., April 16, 2015 to Steve Hays via email at steve.hays@chelanpud.org. I have provided the report in both MSWORD and PDF formats for your convenience. Please feel free to use the review features in MSWORD to make your suggested edits. However, in order to facilitate documentation of your comments and Chelan PUD's responses to comments regarding significant substantive issues, please provide those comments and any supportive rationales or data in a separate document so that it can be incorporated into the record of consultation.

Pursuant to License Article 405, Chelan PUD will file the Final Lake Chelan Annual Flow and Water Temperature Report with FERC and post it to the Lake Chelan License Implementation web page.

All comments received will be appended to the Final Lake Chelan Annual Flow and Water Temperature Report 2014 with a notation regarding how each comment or recommendation was incorporated in the report, or, if not incorporated, the reasons why the comment was not incorporated.

If you have any questions, please do not hesitate to contact me at (509-661-4181).

Steven Hays

Fish and Wildlife Senior Advisor

steve.hays@chelanpud.org

(509) 661-4181

LAKE CHELAN
ANNUAL FLOW AND WATER TEMPERATURE REPORT
2014

LICENSE ARTICLES 405 & 408

Draft

LAKE CHELAN HYDROELECTRIC PROJECT
FERC Project No. 637

March 16, 2014

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

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EXECUTIVE SUMMARY

Chelan PUD received a new license (License) from the Federal Energy Regulatory Commission (FERC) on November 6, 2006, authorizing Chelan PUD to operate the Lake Chelan dam and powerhouse for a period of 50 years. The License conditions require that Chelan PUD provide minimum flows to the Chelan River and monitor those flows and water temperatures at various locations. The License required the construction of a Low Level Outlet at Chelan Dam, a Reach 4 habitat channel and spawning areas in the tailrace, and operations to protect aquatic life through flow ramping rates and powerhouse operations. The License also requires that Chelan PUD file an Annual Flow and Temperature Report with the FERC documenting compliance with these License requirements.

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3. The runoff forecast for 2014 indicated an average water year, thus minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 habitat channel for salmon and steelhead spawning during their respective spawning periods (October 15 – November 30 and March 15 – May 15). During both the steelhead and the Chinook spawning period, the Chelan River Fishery Forum approved testing an alternative spawning flow using four instead of five pumps. The spawning flow levels during these tests ranged from 277 cfs – 292 cfs, with the exception of a 14 hour period with five pumps for habitat velocity transect measurements on November 5.

Flows were released from the spillway, as needed for lake level control, from May 23 – June 10 and June 23 – July 26. Daily average flow releases for lake level control peaked at 4,322 cfs on July 15, whereas the highest hourly flows of 5,656 occurred on July 23. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 20-21. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 22.

In 2014, Chelan PUD implemented operating criteria for compliance with the two inches per hour ramping rates that were refined in 2011. The refined criteria performed well in 2012 and 2013 during the adjustments of spill flows and when ramping down from flows provided for whitewater boating in September. However, the criteria were further adjusted on June 24, 2014, to be more conservative to prevent deviations that might result if the criteria were interpreted differently than anticipated.

There were 319 salmon redds with eggs incubating in the tailrace from spawning that occurred in 2013. Powerhouse operations for Chinook redd protection, based on results from the previous year's tests, were implemented and monitored to determine if adequate oxygen levels were maintained in Chinook salmon redds. During this study, the tests were designed to maintain minimum generation flows of about 850 cfs. During dive operations to install oxygen probes and sample redds for egg-fry survival measurements, the period of time with no powerhouse flow was limited to a maximum of three hours. The 2013 results indicated that dissolved oxygen levels above 6.0 mg/l can be maintained in most redds, even over repeating cycles of three hours

with no flow followed by one hour at minimum generation. After these studies concluded on March 27, the powerhouse operated with one turbine at full capacity until April 14, by which time emergence of Chinook salmon had concluded.

The powerhouse was intermittently taken out of operation from April 14 – April 22 in order to manage lake refill to meet target elevations for Lake Chelan, then operated with one turbine through May 11. Steelhead spawning surveys were conducted from March – May, but no steelhead spawning was observed in 2014.

During the Chinook spawning period, powerhouse daily average flows were maintained above 2000 cfs from October 15 –November 30, with the exception of operations with one turbine through mid day on October 15 and during a few hours on November 5. A total count of 400 Chinook redds were estimated to have been deposited in the Chelan River Reach 4 (78), tailrace (246), and downstream in the Chelan/Columbia River confluence and Columbia River (76).

Water temperatures were monitored at seven locations in the Chelan River and tailrace. Water temperatures neither increased nor decreased during transit through the Reach 4 habitat channel. The maximum daily average water temperatures measured from upstream to downstream locations were 23.4 °C at the Low Level Outlet, 23.4 °C from top of Reach 1 through end of Reach 3, 23.5 °C at the bottom of Reach 4, and 23.5 °C in the tailrace. The highest hourly temperatures recorded at these locations were 23.7 °C, 25.8 °C, 25.7 °C and 24.2 °C, respectively. The highest 7-DADMax temperatures recorded were 23.2 °C at the top of Reach 1, 25.1 °C and 25.0 °C at the ends of Reaches 1 and 3, and 25.1 °C at the bottom of Reach 4.

SECTION 1: INTRODUCTION

The Lake Chelan Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). The Federal Energy Regulatory Commission (FERC) license for operation of this project, issued on November 6, 2006, authorizes Chelan PUD to operate the Lake Chelan dam and powerhouse for a period of 50 years. As part of the normal operation of the Project, Chelan PUD withdraws water from Lake Chelan for power generation and discharges that water through the powerhouse into an excavated tailrace, which leads to the confluence of the Chelan River and the Columbia River. Flows released from the Chelan Dam follow the natural channel of the Chelan River, joining with the powerhouse tailrace flows and discharging to the Columbia River. As a requirement of the new License, minimum flows were established for the Chelan River and that flow was initiated on October 14, 2009.

Chelan PUD filed an Operations Compliance Monitoring Plan (OCMP), as required in License Article 405, which describes how Chelan PUD operates to meet: (1) the instream flows, ramping rates, and tailrace flows as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the Settlement Agreement; (2) and the lake levels as set forth in Article 8 of the Settlement Agreement and Chapter 8 of the Comprehensive Plan. The OCMP includes the specifics of flow measurement techniques, electronic flow data posting, quarterly and annual reporting requirements, and an implementation schedule.

Chelan PUD filed a Threatened and Endangered Species Protection Plan (TESPP), as required in License Article 408, which describes: (1) how Chelan PUD implemented provisions for timely development of a system to release water at the Lake Chelan Dam or pump water from the project powerhouse tailrace to the Chelan River, and subsequent operation of that system to continuously maintain flows equal to or greater than the flows required for Chelan River Reach 4; and (2) methods and schedules for monitoring of flows in the project tailrace and in Reach 4 of the Chelan River and annual reporting of the monitoring results, as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the Settlement Agreement, and (3) methods for timely determination of the need to take actions to improve water quality characteristics adversely affecting anadromous fish, and identification and implementation of appropriate actions.

The OCMP and TESPP were submitted to the FERC on May 4, 2007 and the FERC issued an order approving the TESPP on November 28, 2007 and an order modifying and approving the OCMP on November 30, 2007. Both the OCMP and TESPP require the recording and reporting of flows in the Chelan River, to evaluate meeting minimum flow requirements, protection of fish habitat and protection of salmon and steelhead eggs incubating in the tailrace. The TESPP also includes annual reporting of water temperature monitoring required in the Lake Chelan Settlement Agreement. The order approving the OCMP requires that Chelan PUD shall file an Annual Flow Report with the FERC by February 28 of each year. Due to weather and snow conditions that frequently prevented retrieval of temperature loggers in January and February, the FERC granted a request from Chelan PUD to change the filing date of these annual reports to April 30. This Annual Flow and Temperature Report meet the flow and temperature reporting requirements of License Articles 405 and 408.

Chelan PUD manages the level of Lake Chelan and flow releases through the powerhouse and into the Chelan River channel at the dam for power generation and other purposes. License Article 405 requires management of lake levels with priority given to maintaining minimum flows in the Chelan River (initiated in 2009) and reducing high spillway flows into the Chelan River to protect fish habitat. This report includes two sections that correspond to the flow reporting requirements of the FERC order: Section 2, Chelan River Instream Flows and Section 3, Powerhouse Tailrace Security Flows. Section 4 of this report contains the water temperature monitoring that was conducted in 2014. In addition, the FERC order requires that Chelan PUD conduct general water quality assessments in years 6 (2012) and 8 (2014) sufficient to demonstrate that the Chelan River meets water quality standards for dissolved oxygen, total dissolved gas, turbidity and pH. Section 5 of this report documents water quality assessments that address this requirement.

SECTION 2: CHELAN RIVER INSTREAM FLOWS

2.1 Chelan River Instream Flows

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3 (Figure 2-1). The runoff forecast for 2014 was 105 percent of average, which is classified as an "average year" for setting minimum flows during the annual runoff cycle. The 2014 minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 habitat channel for salmon and steelhead spawning during their respective spawning periods (Figure 2-2). There were no minimum flow deviations in 2014.

Flows were released from the spillway, as needed for lake level control, from May 23 – June 10 and June 23 – July 26. These flow releases were managed to meet lake level target elevations and to avoid high spill levels that could damage the Reach 4 habitat channel. Daily average flow releases for lake level control peaked at 4,322 cfs on July 15, whereas the highest hourly flows of 5,656 occurred on July 23. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 20-21. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 22.

Spawning flows were provided for steelhead trout from March 15 – May 14 and for Chinook salmon from October 15-November 30. The Chelan River Fisheries Forum approved testing an alternative spawning flow using four instead of five pumps for both the steelhead and Chinook spawning periods. The spawning flows were provided through the combination of the Low Level Outlet flows and Pump Station flows, maintaining flow levels of at least 277 cfs during the spring steelhead spawning period. On the final day of the steelhead spawning period, flows were increased to 348 cfs overnight, then ramped down one pump at a time on March 14 to a flow of 210 cfs while observers monitored to determine if Chinook fry became stranded during the reduction in flows as each pump was turned off. The flow effects of shutting off the pumps were buffered by increasing the flow from the Low Level Outlet to 210 cfs at the time the pump station shut down began. During the Chinook spawning period, the flow ranged from 279 cfs – 292 cfs. At the end of the Chinook spawning period, flows from the Pump Station were ramped down one pump at a time to avoid fish stranding. Steelhead spawning surveys were conducted from March through May, but no steelhead spawning was observed in 2014. Chinook fry were observed rearing in the Reach 4 habitat channel from mid April through May. Chinook spawning began on October 4 and was completed prior to November 29. There were a total of 400 redds counted in the Chelan River Reach 4, the tailrace and Columbia River at the confluence. There were 78 redds in the Reach 4 habitat channel and upstream pool, 246 in the tailrace and 76 in the Columbia River in Chelan River currents below the confluence.

A tabulation of average daily flows from the Low Level Outlet, Pump Station, combined flows into Reaches 1-3 and Reach 4, powerhouse discharge, spill discharge and hourly lake levels and powerhouse tailwater levels are presented in Appendix A. Hourly data reported quarterly is available at the internet site: http://www.chelanpud.org/lc-Resource-Documents.cfm.

Figure 2-1. Flow Releases to Reaches 1-3 of the Chelan River, 2014.

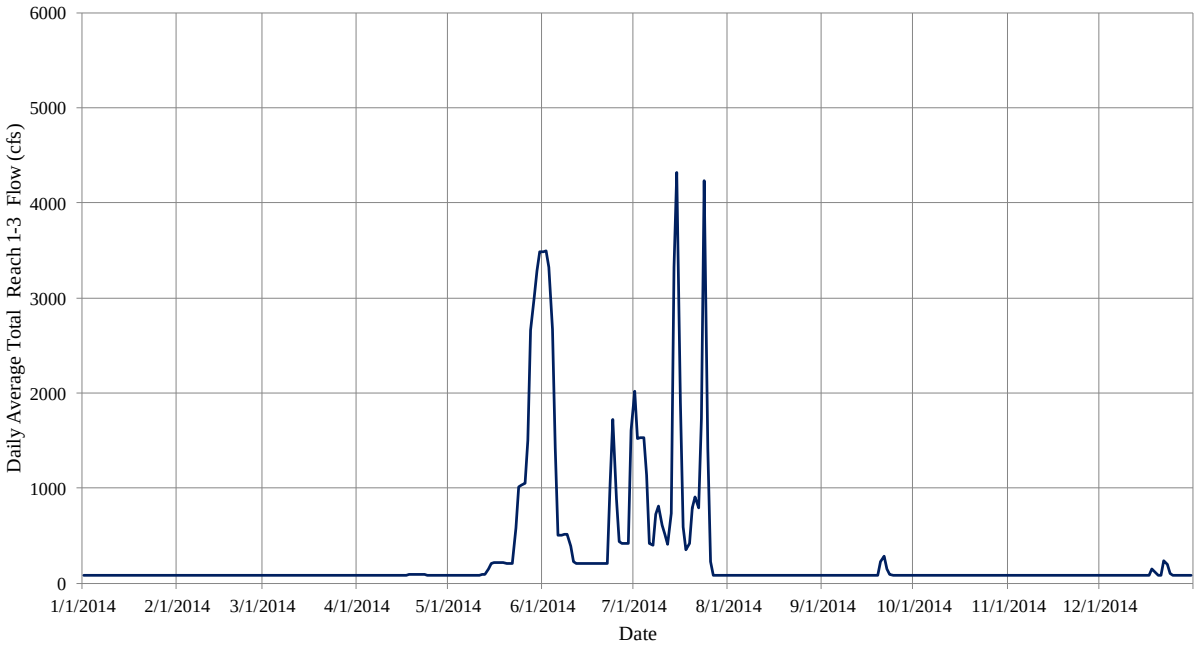
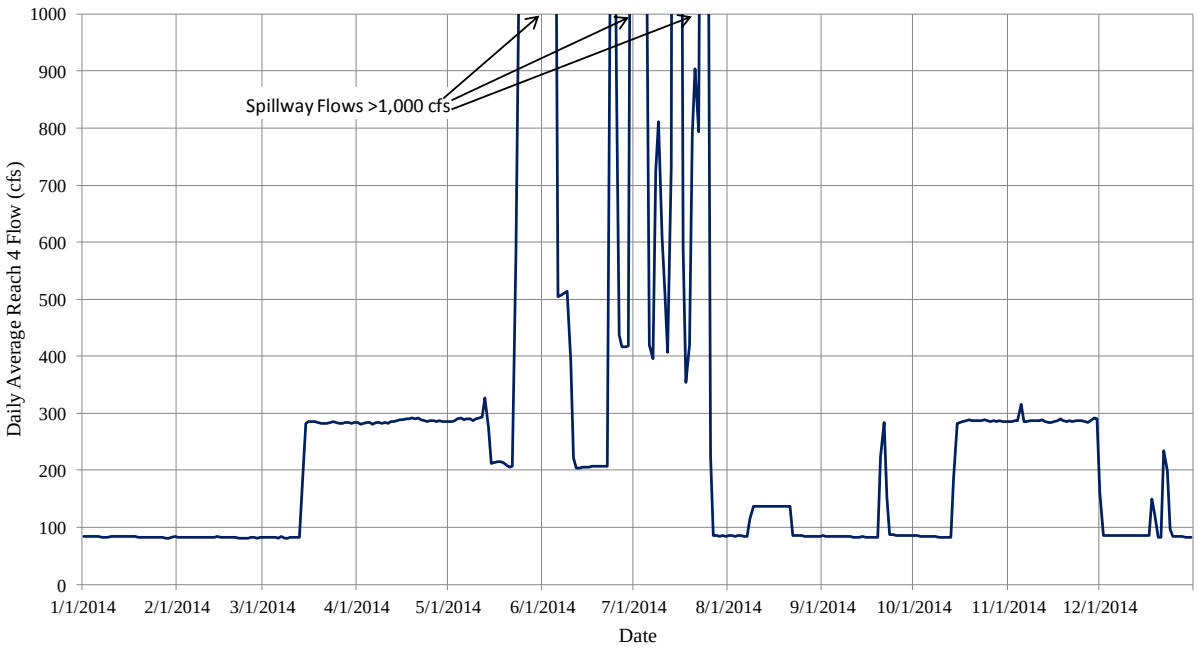


Figure 2-2. Flow Releases to Chelan River Reach 4, 2014.



2.2 Chelan River Ramping Rates

The Lake Chelan Settlement Agreement requires that ramping rates are to be established for the Chelan River to protect aquatic organisms from rapid fluctuations in water levels. The ramping rates for decreases in water levels are initially set at approximately two inches per hour during

the period when juvenile salmon and steelhead fry may be present. The OCMP states that the two inches per hour ramping rates will remain in effect until biological evaluations have determined the actual ramping rates necessary to prevent stranding of fish in the Chelan River. The locations in the Chelan River where water level changes will be measured to determine operating criteria for compliance with ramping rates will be determined in consultation with the Chelan River Fishery Forum.

The year 2014 was the fifth full year of minimum flow operations for the Chelan River since completion of the Low Level Outlet, Reach 4 habitat channel, and Pump Station. Biological evaluations of fish populations with snorkel surveys in the Chelan River Reaches 1-3 and Reach 4 began in 2012. Results of those surveys have been provided to the Chelan River Fisheries Forum and were included in the 2015 Biological Objectives Status Report. Observations during the snorkel surveys, steelhead spawning surveys (weekly March 15-June 1), summer observations during temperature logger replacement (monthly July, August, September) and fall during Chinook spawning surveys (weekly October – November) determined that Chinook salmon fry were present in the Reach 4 habitat channel during the months of April, May and June. No Chinook or steelhead fry were observed prior to mid April and after July. However, ramping rate operations for juvenile fish were followed throughout the year refinement of ramping rates has not yet concluded.

In 2014, Chelan PUD implemented operating criteria for compliance with the two inches per hour ramping rates that were refined in 2011 and managed flow releases using those operating criteria in conjunction with onsite monitoring of actual water level changes. Implementation of the refined criteria was successful in 2012 and 2013 during the adjustments of spill flows and when ramping down from flows provided for whitewater boating in September. However, there was a ramping rate deviation on June 10, 2014 (Appendix C). Ramping rate criteria were further adjusted on June 24, 2014, to be more conservative to prevent deviations that might result if the criteria were interpreted differently than anticipated. The change to more conservative criteria is shown in Table 2-1.

Table 2-1. Ramping Criteria (2014).

Decreasing Spill Ramping Rate Restrictions Except for Plant Safety and System Reliability, the following are License Compliance ramping rate restrictions when reducing spill:	
Maximum Spill Reduction Ramping Rates	
	Ramp Rate
Total Spill* cfs	cfs/hr
1000 < Total Spill	~~250~~ **200**
500 < Total Spill <= 1000	~~100~~ **50**
400 < Total Spill <= 500	~~50~~ **25**
220 < Total Spill <= 400	~~30~~ **25**
80 < Total Spill <= 220	20
* Total Spill = Low Level Outlet + Spill Gates Note: Only reduce spill during daylight hours (to aid fish movement from potential entrapment areas).	

SECTION 3: POWERHOUSE TAILRACE SECURITY FLOWS

3.1 Powerhouse Operations

There were 319 salmon redds with eggs incubating in the tailrace from spawning that occurred in 2013. Powerhouse operations for Chinook redd protection, based on results from the previous year's tests, were implemented and monitored to determine if adequate oxygen levels were maintained in Chinook salmon redds. During this study, the tests were designed to maintain minimum generation flows of about 850 cfs. During dive operations to install oxygen probes and sample redds for egg-fry survival measurements, the period of time with no powerhouse flow was limited to a maximum of three hours. The 2013 results indicated that dissolved oxygen levels above 6.0 mg/l can be maintained in most redds, even over repeating cycles of three hours with no flow followed by one hour at minimum generation. After these studies concluded on March 27, the powerhouse operated with one turbine at full capacity until April 14, by which time emergence of Chinook salmon had concluded.

The powerhouse was intermittently taken out of operation from April 14 – April 22 in order to manage lake refill to meet target elevations for Lake Chelan, then operated with one turbine through May 11. Steelhead spawning surveys were conducted from March – May, but no steelhead spawning was observed in 2014.

During the Chinook spawning period, powerhouse daily average flows were maintained above 2,000 cfs from October 15 –November 30, with the exception of operations with one turbine

through mid day on October 15 and during a few hours on November 5. A total count of 400 Chinook redds were estimated to have been deposited in the Chelan River Reach 4 (78), tailrace (246), and downstream in the Chelan/Columbia River confluence and Columbia River (76). Powerhouse flows were above 2,000 cfs from December 1 – 31, with the exception of two daily periods of no flow (less than 3 hours each) from December 8 – 12 for installation of oxygen monitoring equipment in Chinook redds and to sample redds for egg-fry survival measurements.

Water surface elevations in the tailrace can fluctuate by several feet over the course of a day due to changes in Columbia River flows that affect the backwater curve of the Rocky Reach reservoir. The water level fluctuations in the tailrace are reduced when the Chelan Powerhouse is operating. In past years, temporary dewatering of a few Chinook redds in shallow areas had been observed when the powerhouse was not operating and Columbia River flows were low. During tailrace spawning habitat construction in 2008 these areas were graded to prevent dewatering. In summer of 2014, this area was again excavated and graded to remove river gravels that had accumulated since 2008. The water levels in the tailrace remained above 707.5 feet most of the time and never dropped below 707.0 feet from January 1 – May 31 and October 15 – December 31. Some minor dewatering of redds was observed in spring 2014, which led to the excavation and regarding of this area in summer prior to the October Chinook spawning period. The daily average tailwater levels measured at the powerhouse are shown in Figure 3-2.

Figure 3-1. Chelan Powerhouse Daily Average Flows, 2014.

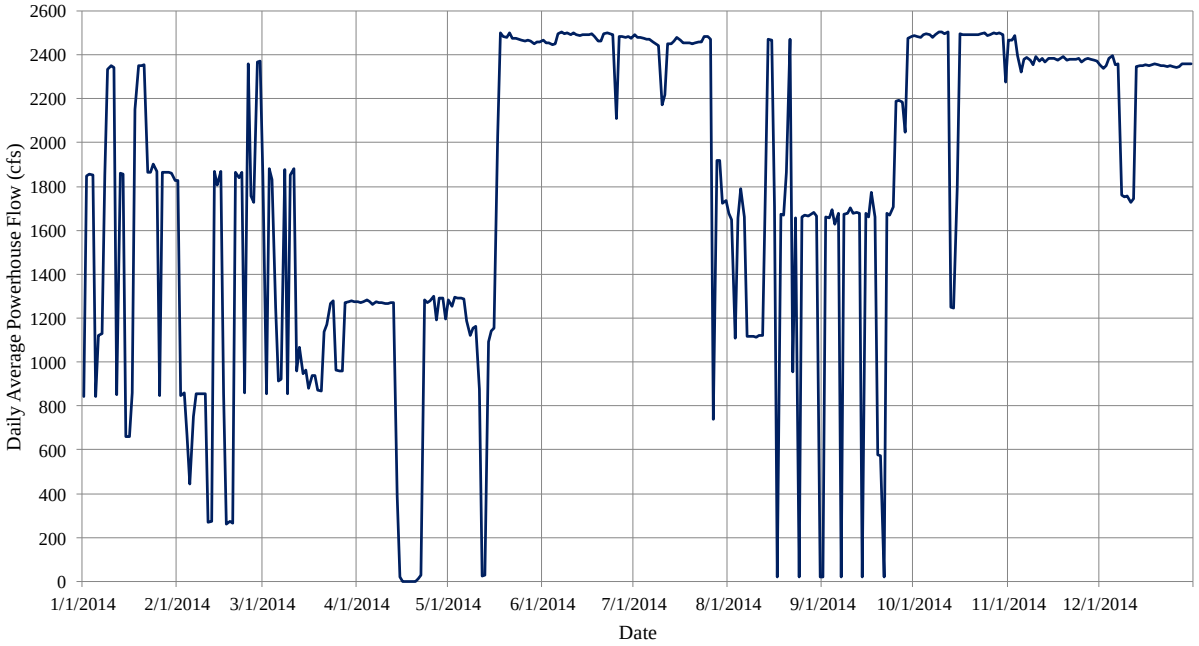
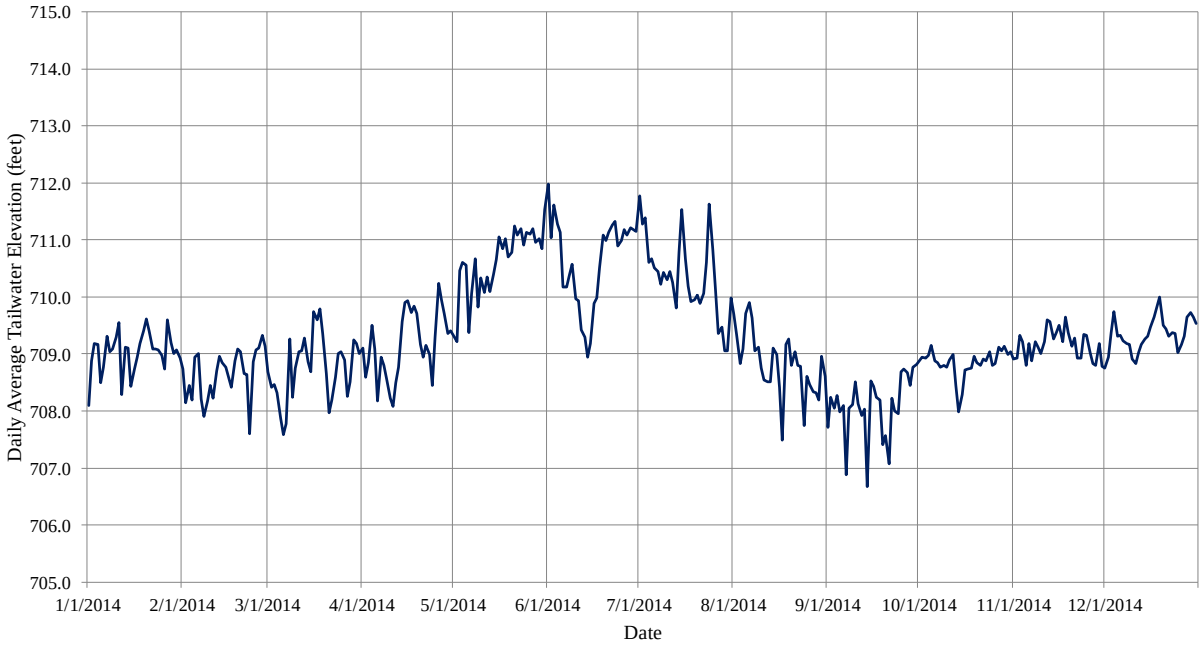


Figure 3-2. Chelan Powerhouse Daily Average Tailwater Elevations, 2013.



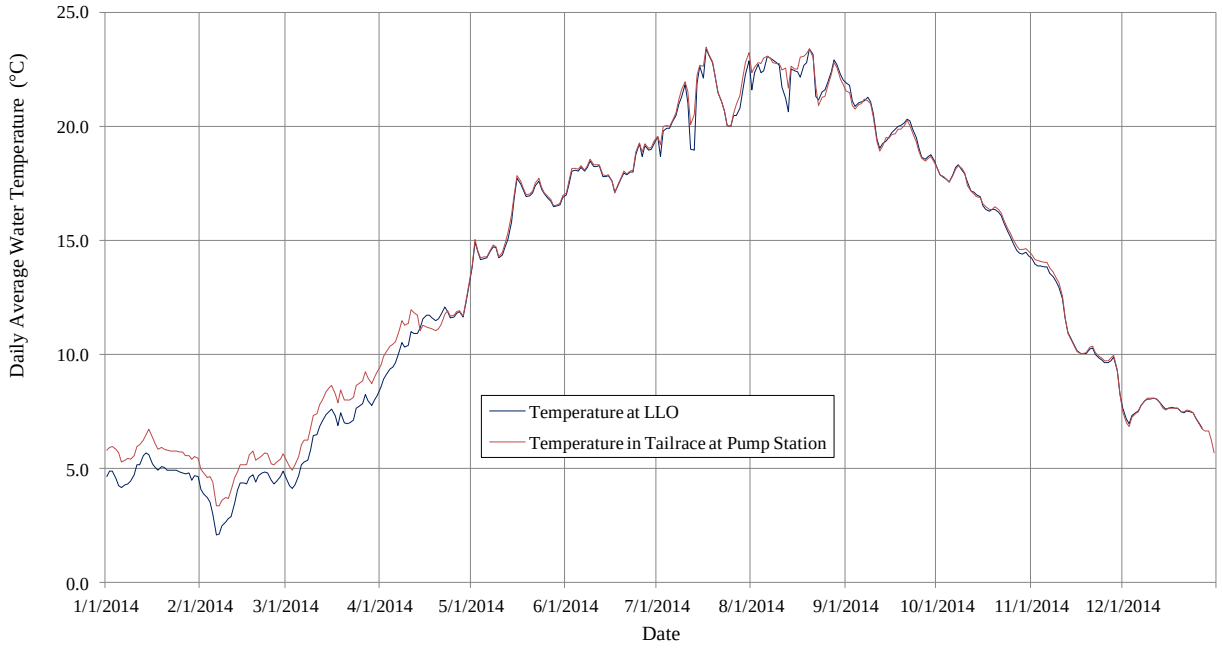
SECTION 4: WATER TEMPERATURE MONITORING

4.1 Water Temperatures Released to Chelan River and Tailrace

Automated water temperature monitoring equipment is installed at two locations, within the pipe that draws water from the base of the Chelan Dam and discharges to the Chelan River through the Low Level Outlet and in the Chelan Powerhouse Tailrace from a sensor mounted on the Pump Station intake screens. These monitoring locations measure the water temperatures that reflect the coolest water available for the Chelan River (Low Level Outlet temperature) and the average of water temperatures arriving at the face of Chelan Dam as drawn through the powerhouse intakes (Chelan Powerhouse Tailrace). Water temperatures measured in the tailrace also represent the temperature of water that is being discharged to the Reach 4 habitat channel when the Pump Station is in operation. Each of these devices was out of service at times in 2014.

Water temperatures from these sources (Figure 4-1) generally show little stratification in water temperatures at the face of Chelan Dam. The maximum daily average water temperature measured in the Low Level Outlet pipe was 23.4 °C. Hourly water temperatures peaked at 23.7 °C on July 17 and again on August 20. Tailrace maximum daily average temperature was 23.5°C, while hourly temperatures peaked at 24.2 °C on August 17.

Figure 4-1. Low Level Outlet and Tailrace Daily Average Water Temperatures.



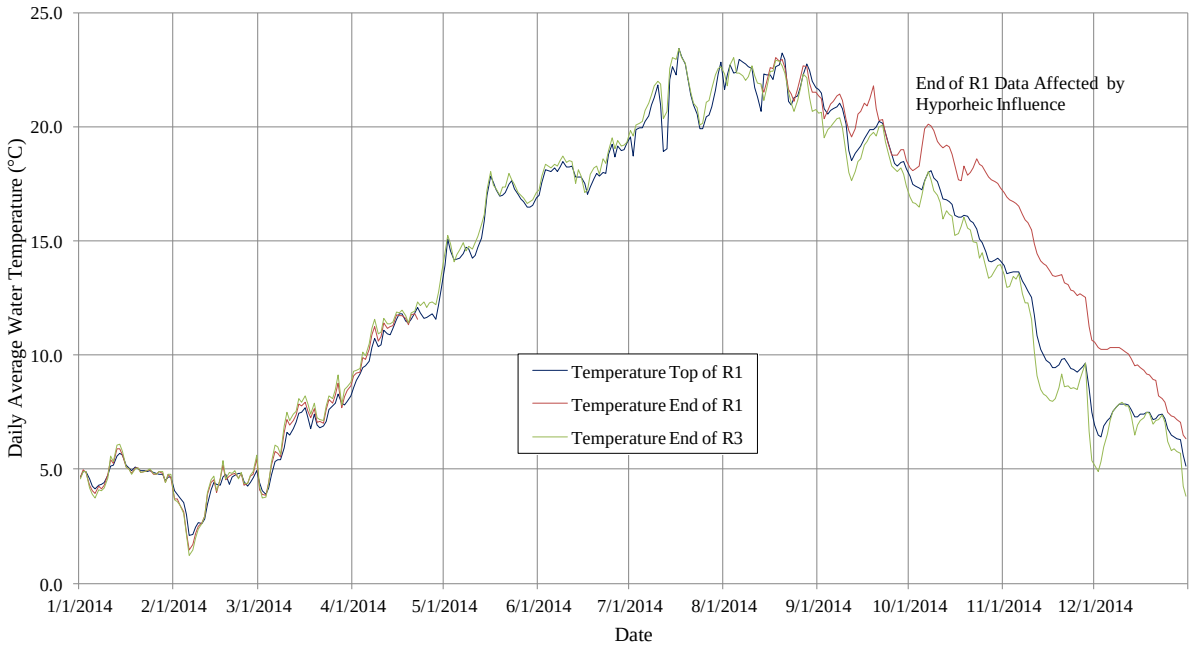
4.2 Water Temperatures in Chelan River Reaches 1-3.

Water temperatures are monitored at three locations with temperature recording data loggers (Onset HOBO Water Temp Pro v2) that are set to record the water temperature at hourly intervals. These locations are at the top of Reach 1, which measures the temperature of water entering the Chelan River from the Low Level Outlet and the spillway. The location of this

temperature logger is set below the mixing zone for these sources of water. The second location is at the end of Reach 1, which is the reach of the Chelan River that has the lowest gradient and least profile shading, thus the greatest potential for water temperature heating during the spring and summer. The third location is at the end of Reach 3, where the Chelan River exits the series of cascades and falls that are the upstream barrier to anadromous fish. The temperature loggers at each location are exchanged several times during the year to retrieve the data. These data are reported quarterly during most of the year, with monthly reporting for July, August and September. These data reports are available at http://www.chelanpud.org/lc-Resource-Documents-WaterQuality.cfm.

The water temperatures recorded at the monitored Reaches in 2014 demonstrated small differences in daily average water temperature between Reaches (Figure 4-2). However, the daily maximum water temperature increased above the temperature at the Low Level Outlet during summer and decreased during the fall. This is not unexpected because the water exiting Lake Chelan is affected by the heat sink effect of the lake's large volume. Water in Lake Chelan is still warming from March – August, but then retains this heat through the late summer and fall, thus water exiting the lake is cooler than sustainable at equilibrium with ambient solar and air temperature conditions through the summer, then tends to be warmer than sustainable through fall and early winter. The maximum daily average water temperatures recorded in 2014 were 23.4 °C at the top of Reach 1 and end of Reach 3. The data logger at the end of Reach 1 was lost during summer spill and replaced in August. The highest hourly temperatures recorded were 23.7 °C, 25.8 °C, and 25.5 °C, respectively for the top of Reach 1, end of Reach 1 and end of Reach 3. The highest temperature recorded was at the end of Reach 1 on August 18.

Figure 4-2. Chelan River Reaches 1-3 Daily Average Water Temperatures.

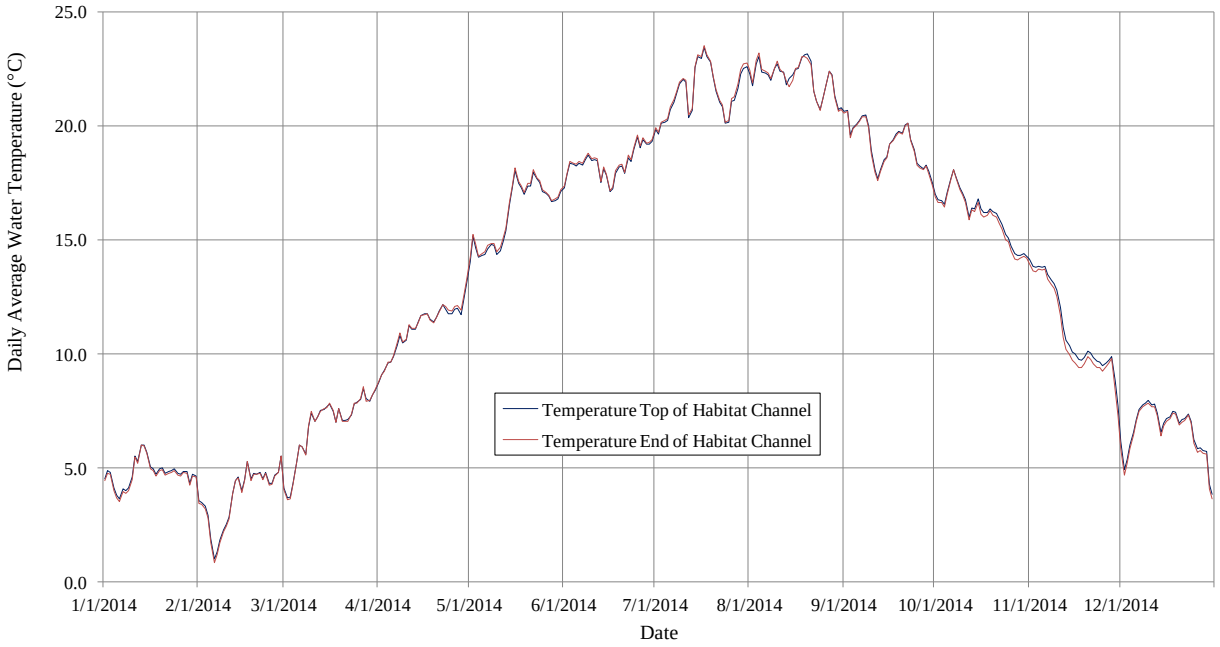


4.3 Water Temperatures in Chelan River Reach 4 Habitat Channel.

Water temperatures are monitored at hourly intervals at two locations (Onset HOBO Water Temp Pro v2), at the upper and lower end of the habitat channel. The upper location records either the water temperature exiting from the pool below the end of Reach 3 or the mixed flows from that source and the Pump Station canal outlet, when the pumps are in operation. The monitoring location at the end of the habitat channel is at the point where habitat channel flows enter into the tailrace, just upstream from where mixing of these flows is expected.

The daily average water temperature data from these locations did not show any evidence of heating as water passed through the habitat channel, despite the lack of significant shade from vegetation under current conditions (Figure 4-3). The maximum daily average temperatures recorded were 23.4 °C at the top and 23.5 °C at the end of the habitat channel. The maximum hourly temperatures were 25.5 °C and 25.7 °C at the upper and lower ends of the habitat channel. These peak temperatures were recorded on August 4.

Figure 4-3. Reach 4 Habitat Channel Daily Average Water Temperatures.



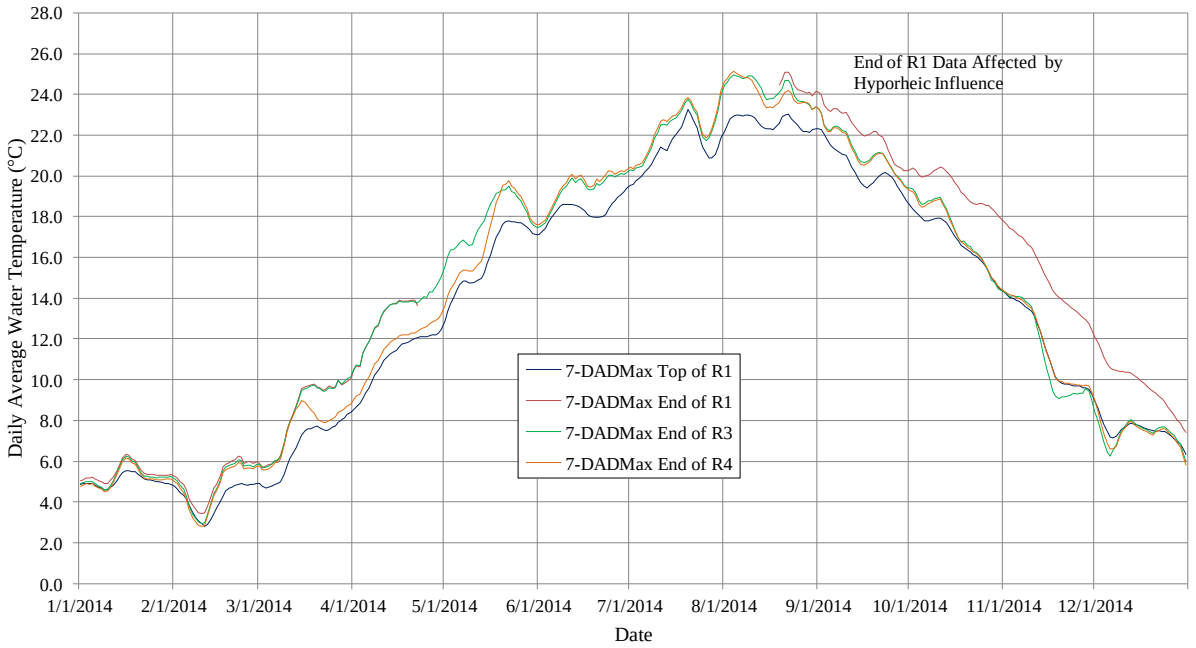
4.4 Chelan River 7-DADMax Water Temperatures Top Reach 1 to Bottom Reach 4.

Washington State water quality standards for temperature establish criteria based on the 7-DADMax (seven day average of daily maximum temperature). The 7-DADMax criterion for the Chelan River is currently 17.5 °C (see Section 5, Table 5-1), with an allowable human effect of 0.3 °C above natural conditions. Natural conditions have not been defined for the Chelan River due to its current status of a river in the initial stages of restoration. However, the temperature of water exiting Lake Chelan is the initial water temperature at the beginning of the Chelan River. This water is either provided exclusively from the Low Level Outlet, which draws the coolest water available at the face of the Chelan Dam, or is from a mix of water from the

spillway and the Low Level Outlet. As water flows through the Chelan River, it either heats or cools, depending on the time of year, since water exiting Lake Chelan is thermally buffered from daily and seasonal environmental influences. The 7-DADMax from the fall through early spring may be warmer at the upper Chelan River (top of Reach 1) than at the lower end where it merges with the tailrace (end of Reach 4). As solar radiation and warmer air temperatures increase from spring through summer, the 7-DADMax will increase as water flows down the Chelan River. The 7-DADMax may be nearly identical at different locations, indicating that the water temperature had reach equilibrium with the external sources of heat gain or loss prior to reaching the downstream monitoring locations.

The 7-DADMax water temperatures from four locations, top of Reach 1, end of Reach 1, end of Reach 3 and end of the Reach 4 Habitat Channel are shown in Figure 4-4. During the periods when flows in Reach 4 are increased for Chinook and steelhead spawning, the water temperatures measured at the end of the Reach 4 Habitat Channel reflects the mix of water from the tailrace and water exiting Reach 3. The difference in temperature is pronounced during the spring when steelhead spawning flows are provided by the pumping station (March 15 – May 15). Prior to and after the spring pumping period, the 7-DADMax at the end of Reach 3 and at the end of the Reach 4 Habitat Channel are nearly identical (Figure 4-4). The 7-DADMax at the top of Reach 1 exceeded the 17.5 °C criterion on May 20, with exceedances extending to October 14, reaching a peak of 23.2 C on July 20. The 7-DADMax at the end of Reach 4 exceeded the criterion from May 16, with exceedances continuing thorough October 15. The highest 7-DADMax reached 25.1 °C on August 4. The highest 7-DADMax at the ends of Reach 1 and Reach 3 were 25.1 °C and 25.0 °C, respectively.

Figure 4-4. The 7-DADMax Water Temperatures for Reaches 1 – 4.



SECTION 5: WATER QUALITY ASSESSMENT

General water quality assessment data was collected in 2014. The requirement for general water quality assessment is that Chelan PUD conduct general water quality assessments in years 6 (2012) and 8 (2014) sufficient to demonstrate that the Chelan River meets water quality standards for dissolved oxygen, total dissolved gas, turbidity and pH. The 401 Certification specifies that this information is to be collected in Reach 4 for dissolved oxygen, turbidity and pH, whereas the total dissolved gas measurements are to be made in Reach 1 below the spillway of the Chelan Dam. Water quality criteria currently applicable to the Chelan River, which has a designated aquatic life use of salmonid spawning, rearing and migration, are shown in Table 5-1.

Table 5-1. Water Quality Criteria for Salmonid Spawning, Rearing and Migration.

	Water Temperature	Dissolved Oxygen	pH	Turbidity	Total Dissolved Gas
Criteria	7-DADMax <=17.5 °C	1 Day Min. 8.0 mg/l	6.5-8.5 Units	-	110 % Saturation
Allowable Human Effect	0.3 °C above natural conditions	0.2 mg/l	< 0.5 Units	5 NTU when Background <= 50 NTU	None

5.1 Assessment of Dissolved Oxygen, pH and Turbidity in Reach 4 Habitat Channel.

Measurements of water temperature, dissolved oxygen and pH were obtained from two locations in the Reach 4 Habitat Channel from October 1 to November 25, 2014. Measurements were obtained using Hydrolab MS5 Minisondes that were programmed to record data every hour. One Minisonde was attached to the same anchor post that is used for the temperature recording data logger at the upper end of the Habitat Channel. The other Minisonde was attached to the anchor post that is used for the temperature logger at the downstream end of the habitat channel.

The dissolved oxygen and pH data collected were within the criteria specified for the current designated uses for the Chelan River (Table 5-1).The temperature, dissolved oxygen and pH data collected with the Minisondes are shown in Figure 5-1. The hourly temperature data regularly collected from the upper and lower end of the Reach 4 Habitat Channel are also shown in these figures, demonstrating the close agreement between these four independent measurements of water temperature. The water temperatures in the Chelan River do not meet the criteria for salmonid spawning, rearing and migration during the summer and the warmest temperatures are usually present during July and August. Water temperature did not fall below the 17.5 °C until October 12. Daily swings in temperature were attenuated after the spawning flows from the pumping station were initiated on October 15. The dissolved oxygen levels in Figure 5-1 demonstrate that despite water temperatures exceeding 17.5 °C the dissolved oxygen level still met the water quality criterion of 8.0 mg/l.

A week of water quality data was also collected at the end of May and early June in 2013 (Figure 5-2). Water quality monitoring in August and October of 2012, which was reported in the 2012 Annual Flow and Water Temperature Report. For each of these monitoring periods, the only water quality criteria that has not been met has been water temperature. The dissolved oxygen and pH levels have met the water quality criteria throughout these monitoring periods. Additional monitoring is scheduled for 2015, with the intent to install instruments as soon as high spill flows subside in the summer and to monitor through September.

The water clarity in the Chelan River is very high throughout the year, except during high spill levels. A single turbidity measurement was taken on October 12, 2013, and the turbidity was 0.04 NTU. The water clarity in August was not visibly any less clear than in October. There is no background turbidity against which to compare the turbidity in the Reach 4 Habitat Channel since there is no construction activity and there are no active erosion sites within the Habitat Channel.

5.2 Assessment of Total Dissolved Gas in Reach 1 Below Chelan Dam Spillway.

There were no measurements for total dissolved gas taken below the Chelan Dam spillway in 2014. When spill was initiated, no safe location could be found for placing an instrument. A secure and representative method for placing an instrument for measuring TDG was installed in 2014 and monitoring will occur in 2015.

Figure 5-1. October – November, 2014, Water Quality Data in Reach 4 Habitat Channel.

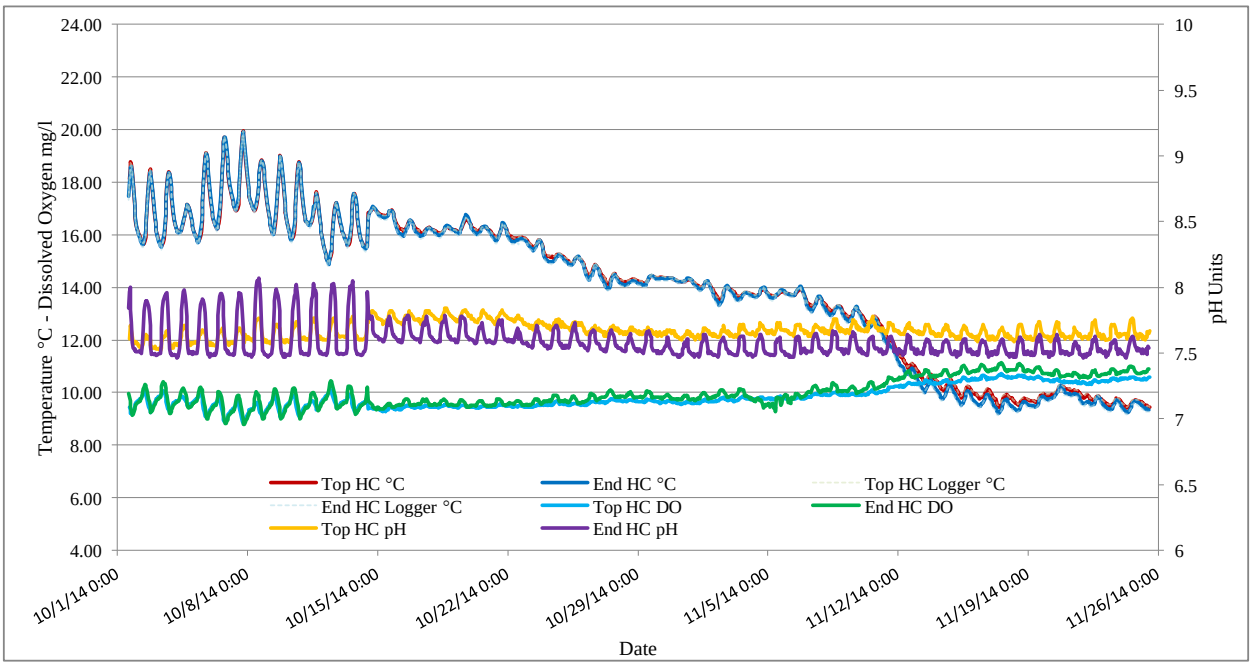
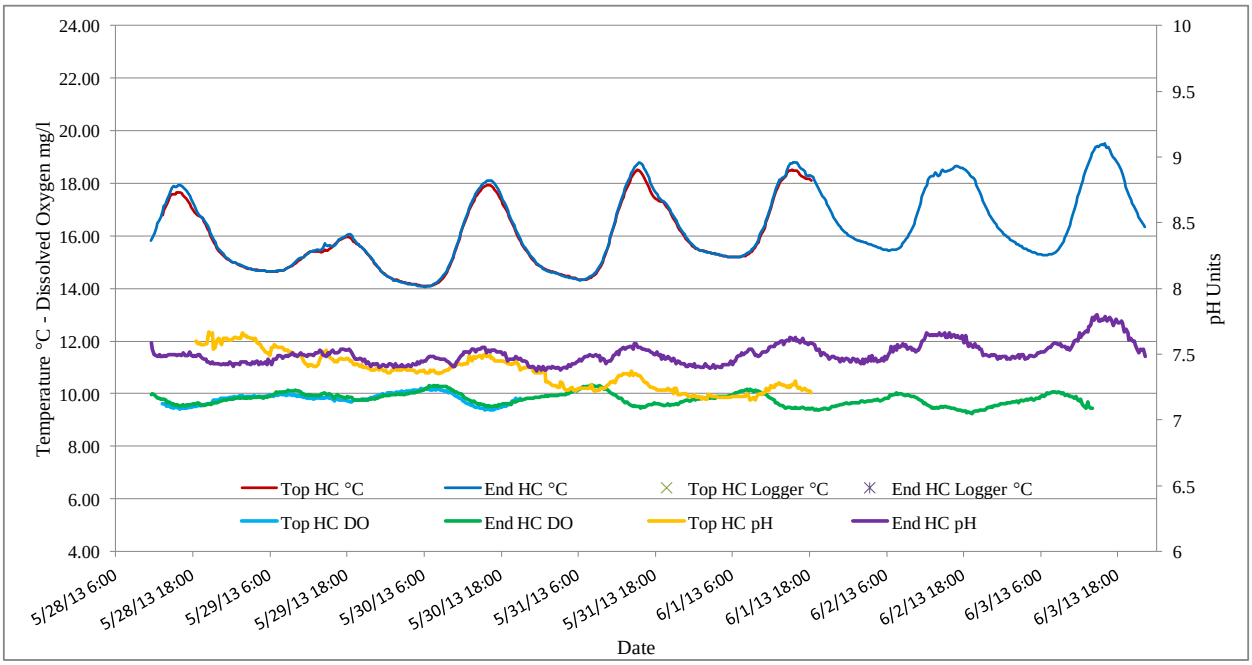


Figure 5-2. May – June, 2013, Water Quality Data in Reach 4 Habitat Channel.



SECTION 6: SUMMARY

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3. The runoff forecast for 2014 indicated an average water year, thus minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 habitat channel for salmon and steelhead spawning during their respective spawning periods (October 15 – November 30 and March 15 – May 15. During both the steelhead and the Chinook spawning period, the Chelan River Fishery Forum approved testing an alternative spawning flow using four instead of five pumps. The spawning flow levels during these tests ranged from 277 cfs – 292 cfs, with the exception of a 14 hour period with five pumps for habitat velocity transect measurements on November 5. There were no minimum flow deviations in 2014.

Flows were released from the spillway, as needed for lake level control, from May 23 – June 10 and June 23 – July 26. Daily average flow releases for lake level control peaked at 4,322 cfs on July 15, whereas the highest hourly flows of 5,656 occurred on July 23. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 20-21. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 22.

In 2014, Chelan PUD implemented operating criteria for compliance with the two inches per hour ramping rates that were refined in 2011. The refined criteria performed well in 2012 and 2013 during the adjustments of spill flows and when ramping down from flows provided for whitewater boating in September. However, the criteria were further adjusted on June 24, 2014, to be more conservative to prevent deviations that might result if the criteria were interpreted differently than anticipated.

There were 319 salmon redds with eggs incubating in the tailrace from spawning that occurred in 2013. Powerhouse operations for Chinook redd protection, based on results from the previous year's tests, were implemented and monitored to determine if adequate oxygen levels were maintained in Chinook salmon redds. During this study, the tests were designed to maintain minimum generation flows of about 850 cfs. During dive operations to install oxygen probes and sample redds for egg-fry survival measurements, the period of time with no powerhouse flow was limited to a maximum of three hours. The 2013 results indicated that dissolved oxygen levels above 6.0 mg/l can be maintained in most redds, even over repeating cycles of three hours with no flow followed by one hour at minimum generation. After these studies concluded on March 27, the powerhouse operated with one turbine at full capacity until April 14, by which time emergence of Chinook salmon had concluded.

The powerhouse was intermittently taken out of operation from April 14 – April 22 in order to manage lake refill to meet target elevations for Lake Chelan, then operated with one turbine through May 11. Steelhead spawning surveys were conducted from March – May, but no steelhead spawning was observed in 2014.

During the Chinook spawning period, powerhouse daily average flows were maintained above 2000 cfs from October 15 –November 30, with the exception of operations with one turbine through mid day on October 15 and during a few hours on November 5. A total count of 400 Chinook redds were estimated to have been deposited in the Chelan River Reach 4 (78), tailrace (246), and downstream in the Chelan/Columbia River confluence and Columbia River (76).

Water temperatures were monitored at seven locations in the Chelan River and tailrace. Water temperatures neither increased nor decreased during transit through the Reach 4 habitat channel. The maximum daily average water temperatures measured from upstream to downstream locations were 23.4 °C at the Low Level Outlet, 23.4 °C from top of Reach 1 through end of Reach 3, 23.5 °C at the bottom of Reach 4, and 23.5 °C in the tailrace. The highest hourly temperatures recorded at these locations were 23.7 °C, 25.8 °C, 25.7 °C and 24.2 °C, respectively. The highest 7-DADMax temperatures recorded were 23.2 °C at the top of Reach 1, 25.1 °C and 25.0 °C at the ends of Reaches 1 and 3, and 25.1 °C at the bottom of Reach 4.

APPENDIX A: DAILY AVERAGE LAKE CHELAN ELEVATIONS, POWERHOUSE FLOWS, TAILWATER ELEVATIONS AND CHELAN RIVER FLOWS FROM SPILL, LOW LEVEL OUTLET AND PUMPING STATION

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
1/1/2014	1089.2	842	708.1	84	0	84	0	84
1/2/2014	1089.2	1848	708.9	84	0	84	0	84
1/3/2014	1089.2	1855	709.2	84	0	84	0	84
1/4/2014	1089.0	1850	709.2	84	0	84	0	84
1/5/2014	1089.0	844	708.5	84	0	84	0	84
1/6/2014	1088.9	1121	708.8	84	0	84	0	84
1/7/2014	1088.9	1128	709.3	83	0	83	0	83
1/8/2014	1088.8	1853	709.0	83	0	83	0	83
1/9/2014	1088.7	2335	709.1	83	0	83	0	83
1/10/2014	1088.6	2350	709.3	83	0	83	0	83
1/11/2014	1088.5	2341	709.6	84	0	84	0	84
1/12/2014	1088.5	852	708.3	84	0	84	0	84
1/13/2014	1088.5	1861	709.1	84	0	84	0	84
1/14/2014	1088.4	1855	709.1	84	0	84	0	84
1/15/2014	1088.4	659	708.4	84	0	84	0	84
1/16/2014	1088.3	660	708.7	84	0	84	0	84
1/17/2014	1088.3	858	708.9	84	0	84	0	84
1/18/2014	1088.3	2153	709.2	84	0	84	0	84
1/19/2014	1088.2	2351	709.4	83	0	83	0	83
1/20/2014	1088.1	2351	709.6	83	0	83	0	83
1/21/2014	1088.0	2354	709.4	82	0	82	0	82
1/22/2014	1087.9	1863	709.1	82	0	82	0	82
1/23/2014	1087.8	1866	709.1	82	0	82	0	82
1/24/2014	1087.7	1900	709.1	82	0	82	0	82
1/25/2014	1087.6	1871	709.0	82	0	82	0	82
1/26/2014	1087.5	847	708.7	82	0	82	0	82
1/27/2014	1087.5	1866	709.6	82	0	82	0	82
1/28/2014	1087.5	1865	709.2	82	0	82	0	82
1/29/2014	1087.4	1866	709.0	81	0	81	0	81
1/30/2014	1087.3	1860	709.1	82	0	82	0	82
1/31/2014	1087.3	1828	708.9	83	0	83	0	83
2/1/2014	1087.2	1829	708.7	83	0	83	0	83
2/2/2014	1087.1	845	708.1	83	0	83	0	83
2/3/2014	1087.0	858	708.5	83	0	83	0	83
2/4/2014	1087.0	663	708.2	83	0	83	0	83
2/5/2014	1087.0	445	708.9	83	0	83	0	83
2/6/2014	1086.9	753	709.0	83	0	83	0	83
2/7/2014	1086.9	854	708.2	82	0	82	0	82
2/8/2014	1086.9	856	707.9	82	0	82	0	82
2/9/2014	1086.9	854	708.2	82	0	82	0	82
2/10/2014	1086.8	856	708.4	82	0	82	0	82
2/11/2014	1086.8	270	708.2	83	0	83	0	83
2/12/2014	1086.9	272	708.7	83	0	83	0	83
2/13/2014	1086.9	1868	709.0	82	0	82	0	82
2/14/2014	1086.9	1807	708.8	82	0	82	2	84
2/15/2014	1086.8	1868	708.8	82	0	82	0	82
2/16/2014	1086.7	857	708.6	82	0	82	0	82
2/17/2014	1086.7	260	708.4	83	0	83	0	83
2/18/2014	1086.8	274	708.9	83	0	83	0	83
2/19/2014	1086.8	266	709.1	83	0	83	0	83

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
2/20/2014	1086.9	1863	709.0	82	0	82	0	82
2/21/2014	1086.8	1839	708.7	82	0	82	0	82
2/22/2014	1086.7	1866	708.6	81	0	81	0	81
2/23/2014	1086.6	859	707.6	81	0	81	0	81
2/24/2014	1086.5	2360	708.9	82	0	82	0	82
2/25/2014	1086.5	1757	709.1	82	0	82	0	82
2/26/2014	1086.4	1729	709.1	82	0	82	0	82
2/27/2014	1086.3	2367	709.3	82	0	82	0	82
2/28/2014	1086.2	2372	709.1	82	0	82	0	82
3/1/2014	1086.1	1848	708.7	82	0	82	0	82
3/2/2014	1086.0	857	708.4	82	0	82	0	82
3/3/2014	1085.9	1879	708.5	82	0	82	0	82
3/4/2014	1085.9	1830	708.3	82	0	82	0	82
3/5/2014	1085.8	1247	707.9	82	0	82	0	82
3/6/2014	1085.8	915	707.6	82	0	82	0	82
3/7/2014	1085.8	921	707.8	82	0	82	2	83
3/8/2014	1085.8	1878	709.3	82	0	82	0	82
3/9/2014	1085.8	856	708.2	82	0	82	0	82
3/10/2014	1085.9	1853	708.8	82	0	82	0	82
3/11/2014	1085.9	1881	709.0	82	0	82	0	82
3/12/2014	1085.9	958	709.1	82	0	82	0	82
3/13/2014	1085.9	1066	709.3	82	0	82	0	82
3/14/2014	1085.9	947	708.9	82	0	82	115	197
3/15/2014	1085.9	962	708.7	82	0	82	201	283
3/16/2014	1086.0	880	709.7	82	0	82	204	286
3/17/2014	1086.0	936	709.6	83	0	83	203	286
3/18/2014	1086.1	937	709.8	82	0	82	204	286
3/19/2014	1086.1	873	709.4	82	0	82	202	284
3/20/2014	1086.1	869	708.7	82	0	82	200	282
3/21/2014	1086.2	1139	708.0	82	0	82	200	282
3/22/2014	1086.2	1169	708.2	83	0	83	200	282
3/23/2014	1086.2	1268	708.6	83	0	83	201	284
3/24/2014	1086.2	1280	709.0	83	0	83	202	285
3/25/2014	1086.2	963	709.0	83	0	83	201	284
3/26/2014	1086.2	959	708.9	82	0	82	200	282
3/27/2014	1086.2	958	708.3	82	0	82	201	283
3/28/2014	1086.2	1270	708.5	82	0	82	201	283
3/29/2014	1086.2	1273	709.2	82	0	82	201	283
3/30/2014	1086.2	1278	709.2	82	0	82	200	282
3/31/2014	1086.2	1274	709.0	82	0	82	202	284
4/1/2014	1086.2	1274	709.1	82	0	82	202	284
4/2/2014	1086.2	1271	708.6	82	0	82	199	281
4/3/2014	1086.1	1273	708.9	82	0	82	200	283
4/4/2014	1086.1	1283	709.5	83	0	83	200	283
4/5/2014	1086.1	1275	709.1	83	0	83	200	283
4/6/2014	1086.1	1263	708.2	83	0	83	198	281
4/7/2014	1086.2	1277	708.9	83	0	83	201	284
4/8/2014	1086.2	1272	708.8	84	0	84	200	283
4/9/2014	1086.3	1270	708.6	84	0	84	198	282
4/10/2014	1086.3	1267	708.2	84	0	84	199	283

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
4/11/2014	1086.4	1265	708.1	85	0	85	197	282
4/12/2014	1086.5	1272	708.5	85	0	85	201	286
4/13/2014	1086.5	1273	708.8	85	0	85	201	286
4/14/2014	1086.6	392	709.6	86	0	86	201	287
4/15/2014	1086.7	22	709.9	87	0	87	201	288
4/16/2014	1086.8	0	709.9	87	0	87	202	289
4/17/2014	1086.9	0	709.7	87	0	87	203	291
4/18/2014	1087.1	0	709.8	88	0	88	201	289
4/19/2014	1087.2	0	709.7	89	0	89	203	291
4/20/2014	1087.4	0	709.2	89	0	89	201	290
4/21/2014	1087.5	10	708.9	90	0	90	202	292
4/22/2014	1087.6	28	709.2	89	0	89	199	289
4/23/2014	1087.7	1281	709.0	88	0	88	200	288
4/24/2014	1087.8	1272	708.5	86	0	86	199	285
4/25/2014	1087.9	1280	709.3	84	0	84	203	287
4/26/2014	1088.0	1300	710.2	84	0	84	203	287
4/27/2014	1088.0	1193	709.9	84	0	84	201	286
4/28/2014	1088.0	1293	709.7	84	0	84	202	286
4/29/2014	1088.1	1293	709.4	83	0	83	202	285
4/30/2014	1088.1	1196	709.4	83	0	83	202	285
5/1/2014	1088.2	1283	709.3	83	0	83	202	285
5/2/2014	1088.3	1253	709.2	84	0	84	201	285
5/3/2014	1088.5	1295	710.5	84	0	84	203	287
5/4/2014	1088.8	1291	710.6	85	0	85	205	291
5/5/2014	1089.0	1292	710.6	86	0	86	206	292
5/6/2014	1089.2	1286	709.4	86	0	86	203	289
5/7/2014	1089.4	1187	710.1	85	0	85	204	289
5/8/2014	1089.6	1119	710.7	85	0	85	206	290
5/9/2014	1089.8	1154	709.8	85	0	85	201	287
5/10/2014	1090.1	1162	710.3	86	0	86	205	291
5/11/2014	1090.2	876	710.1	86	0	86	206	292
5/12/2014	1090.4	23	710.3	89	0	89	205	293
5/13/2014	1090.6	29	710.1	89	0	89	237	326
5/14/2014	1090.9	1091	710.4	149	0	149	125	275
5/15/2014	1091.2	1144	710.6	211	0	211	0	211
5/16/2014	1091.7	1153	711.1	213	0	213	0	213
5/17/2014	1092.2	2031	710.8	215	0	215	0	215
5/18/2014	1092.5	2499	711.0	216	0	216	0	216
5/19/2014	1092.8	2485	710.7	214	0	214	0	214
5/20/2014	1093.0	2479	710.8	208	0	208	0	208
5/21/2014	1093.3	2502	711.2	206	0	206	0	206
5/22/2014	1093.6	2474	711.1	207	0	207	0	207
5/23/2014	1093.9	2475	711.2	209	373	582	0	582
5/24/2014	1094.3	2469	710.9	211	806	1017	0	1017
5/25/2014	1094.6	2467	711.1	212	822	1035	0	1035
5/26/2014	1094.8	2465	711.1	213	836	1049	0	1049
5/27/2014	1095.0	2467	711.2	214	1283	1497	0	1497
5/28/2014	1095.1	2463	711.0	211	2448	2659	0	2659
5/29/2014	1095.1	2451	711.0	207	2804	3011	0	3011
5/30/2014	1095.1	2458	710.8	207	3082	3289	1	3290

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
5/31/2014	1095.0	2458	711.5	206	3284	3490	0	3490
6/1/2014	1095.0	2465	712.0	207	3282	3488	0	3488
6/2/2014	1095.0	2454	711.0	207	3293	3500	0	3501
6/3/2014	1095.2	2455	711.6	207	3117	3325	0	3325
6/4/2014	1095.3	2446	711.3	207	2461	2668	0	2668
6/5/2014	1095.5	2450	711.1	208	1221	1428	0	1428
6/6/2014	1095.7	2495	710.2	208	297	505	0	505
6/7/2014	1095.9	2505	710.2	209	299	508	0	508
6/8/2014	1096.1	2495	710.4	209	302	511	0	511
6/9/2014	1096.3	2502	710.6	210	303	514	0	514
6/10/2014	1096.5	2491	710.0	232	160	392	0	392
6/11/2014	1096.6	2500	709.9	222	0	222	0	222
6/12/2014	1096.8	2493	709.4	203	0	203	0	203
6/13/2014	1097.0	2489	709.3	204	0	204	0	204
6/14/2014	1097.2	2491	709.0	205	0	205	0	205
6/15/2014	1097.3	2490	709.2	206	0	206	0	206
6/16/2014	1097.4	2494	709.9	206	0	206	0	206
6/17/2014	1097.5	2494	710.0	206	0	206	0	206
6/18/2014	1097.7	2485	710.5	207	0	207	0	207
6/19/2014	1097.8	2462	711.1	207	0	207	0	207
6/20/2014	1097.9	2463	711.0	207	0	207	0	207
6/21/2014	1098.0	2497	711.1	208	0	208	0	208
6/22/2014	1098.1	2498	711.3	208	0	208	0	208
6/23/2014	1098.2	2494	711.3	208	827	1035	0	1035
6/24/2014	1098.4	2491	710.9	209	1511	1720	0	1720
6/25/2014	1098.5	2110	711.0	210	678	887	0	887
6/26/2014	1098.6	2485	711.2	210	227	437	0	437
6/27/2014	1098.8	2483	711.1	210	206	417	0	417
6/28/2014	1098.9	2479	711.2	211	206	417	0	417
6/29/2014	1099.1	2485	711.2	211	206	417	0	417
6/30/2014	1099.1	2476	711.1	212	1395	1608	0	1608
7/1/2014	1099.1	2493	711.8	212	1811	2023	0	2023
7/2/2014	1099.2	2478	711.3	212	1307	1519	0	1519
7/3/2014	1099.3	2479	711.4	213	1315	1527	0	1527
7/4/2014	1099.4	2474	710.6	212	1319	1531	0	1531
7/5/2014	1099.3	2473	710.7	212	925	1138	0	1138
7/6/2014	1099.4	2470	710.5	213	208	420	0	420
7/7/2014	1099.5	2457	710.4	213	183	396	0	396
7/8/2014	1099.6	2453	710.2	214	512	725	0	725
7/9/2014	1099.7	2443	710.4	214	597	811	0	811
7/10/2014	1099.8	2173	710.3	214	393	607	0	607
7/11/2014	1099.8	2217	710.4	215	298	513	0	513
7/12/2014	1099.9	2450	710.3	215	191	406	0	406
7/13/2014	1100.0	2453	709.8	216	517	732	0	732
7/14/2014	1100.0	2464	710.8	214	3110	3325	0	3325
7/15/2014	1099.8	2478	711.5	213	4108	4322	0	4322
7/16/2014	1099.8	2468	710.7	213	1689	1902	0	1902
7/17/2014	1099.9	2455	710.2	213	374	587	0	587
7/18/2014	1099.9	2453	709.9	161	192	354	0	354
7/19/2014	1099.9	2453	710.0	89	331	420	0	420

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
7/20/2014	1099.9	2452	710.0	90	699	789	0	789
7/21/2014	1099.9	2455	709.9	87	817	904	0	904
7/22/2014	1099.8	2458	710.1	85	709	794	0	794
7/23/2014	1099.8	2460	710.6	85	1646	1731	0	1731
7/24/2014	1099.6	2484	711.6	84	4149	4233	0	4233
7/25/2014	1099.5	2482	710.8	84	1333	1417	0	1417
7/26/2014	1099.4	2469	710.1	85	142	226	0	226
7/27/2014	1099.4	740	709.4	85	0	85	0	85
7/28/2014	1099.4	1920	709.5	85	0	85	0	85
7/29/2014	1099.4	1918	709.1	85	0	85	0	85
7/30/2014	1099.5	1722	709.1	85	0	85	0	85
7/31/2014	1099.5	1737	710.0	85	0	85	0	85
8/1/2014	1099.5	1678	709.7	85	0	85	0	85
8/2/2014	1099.5	1647	709.3	85	0	85	0	85
8/3/2014	1099.5	1108	708.8	84	0	84	0	84
8/4/2014	1099.5	1656	709.1	85	0	85	0	85
8/5/2014	1099.5	1788	709.7	85	0	85	0	85
8/6/2014	1099.5	1660	709.9	85	0	85	0	85
8/7/2014	1099.5	1118	709.6	84	0	84	0	84
8/8/2014	1099.5	1115	709.1	84	0	84	30	115
8/9/2014	1099.5	1116	709.1	84	0	84	52	136
8/10/2014	1099.5	1114	708.8	84	0	84	52	136
8/11/2014	1099.5	1121	708.5	85	0	85	52	137
8/12/2014	1099.5	1120	708.5	85	0	85	52	137
8/13/2014	1099.6	1776	708.5	85	0	85	52	137
8/14/2014	1099.6	2473	709.1	85	0	85	52	137
8/15/2014	1099.6	2466	709.0	85	0	85	52	136
8/16/2014	1099.6	1706	708.4	85	0	85	51	136
8/17/2014	1099.6	20	707.5	86	0	86	51	137
8/18/2014	1099.7	1675	709.2	85	0	85	52	137
8/19/2014	1099.7	1671	709.3	85	0	85	52	137
8/20/2014	1099.7	1866	708.8	85	0	85	52	136
8/21/2014	1099.6	2473	709.0	85	0	85	52	137
8/22/2014	1099.5	957	708.8	85	0	85	0	85
8/23/2014	1099.5	1658	708.8	85	0	85	0	85
8/24/2014	1099.5	20	707.7	85	0	85	0	85
8/25/2014	1099.5	1663	708.6	85	0	85	0	85
8/26/2014	1099.5	1671	708.5	85	0	85	0	85
8/27/2014	1099.4	1665	708.3	85	0	85	0	85
8/28/2014	1099.4	1674	708.3	84	0	84	0	84
8/29/2014	1099.3	1680	708.2	84	0	84	0	84
8/30/2014	1099.3	1665	709.0	84	0	84	0	84
8/31/2014	1099.3	20	708.6	85	0	85	0	85
9/1/2014	1099.3	20	707.7	85	0	85	0	85
9/2/2014	1099.3	1661	708.2	84	0	84	0	84
9/3/2014	1099.2	1656	708.1	84	0	84	0	84
9/4/2014	1099.1	1695	708.3	84	0	84	0	84
9/5/2014	1099.0	1628	708.0	84	0	84	0	84
9/6/2014	1099.0	1677	708.1	84	0	84	0	84
9/7/2014	1099.0	20	706.9	85	0	85	0	85

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
9/8/2014	1099.0	1673	708.1	84	0	84	0	84
9/9/2014	1098.9	1679	708.1	83	0	83	0	83
9/10/2014	1098.7	1704	708.5	83	0	83	0	83
9/11/2014	1098.7	1678	708.1	83	0	83	0	83
9/12/2014	1098.6	1683	707.9	83	0	83	0	83
9/13/2014	1098.5	1678	708.0	83	0	83	0	83
9/14/2014	1098.5	20	706.7	83	0	83	0	83
9/15/2014	1098.4	1679	708.5	83	0	83	0	83
9/16/2014	1098.4	1662	708.4	82	0	82	0	82
9/17/2014	1098.3	1773	708.2	82	0	82	0	82
9/18/2014	1098.2	1661	708.2	82	0	82	0	82
9/19/2014	1098.2	578	707.4	82	0	82	0	82
9/20/2014	1098.2	572	707.6	224	0	224	0	224
9/21/2014	1098.2	20	707.1	284	0	284	0	284
9/22/2014	1098.1	1676	708.2	153	0	153	0	153
9/23/2014	1098.1	1670	708.0	88	0	88	0	88
9/24/2014	1098.0	1708	708.0	87	0	87	0	87
9/25/2014	1098.0	2188	708.7	86	0	86	0	86
9/26/2014	1097.9	2193	708.7	86	0	86	0	86
9/27/2014	1097.9	2186	708.7	86	0	86	0	86
9/28/2014	1097.8	2047	708.5	86	0	86	0	86
9/29/2014	1097.7	2475	708.8	86	0	86	0	86
9/30/2014	1097.6	2484	708.8	86	0	86	0	86
10/1/2014	1097.4	2489	708.9	85	0	85	0	85
10/2/2014	1097.3	2483	708.9	85	0	85	0	85
10/3/2014	1097.2	2479	708.9	85	0	85	0	85
10/4/2014	1097.0	2490	709.0	84	0	84	0	84
10/5/2014	1096.9	2497	709.2	84	0	84	0	84
10/6/2014	1096.8	2493	708.9	84	0	84	0	84
10/7/2014	1096.7	2481	708.8	84	0	84	0	84
10/8/2014	1096.6	2491	708.8	83	0	83	0	83
10/9/2014	1096.5	2504	708.8	83	0	83	0	83
10/10/2014	1096.3	2504	708.8	83	0	83	0	83
10/11/2014	1096.2	2498	708.9	83	0	83	0	83
10/12/2014	1096.1	2505	709.0	82	0	82	0	82
10/13/2014	1096.0	1251	708.5	82	0	82	0	82
10/14/2014	1096.0	1247	708.0	82	0	82	104	186
10/15/2014	1095.9	1792	708.3	82	0	82	200	282
10/16/2014	1095.8	2495	708.7	82	0	82	203	284
10/17/2014	1095.7	2492	708.7	83	0	83	202	286
10/18/2014	1095.6	2492	708.8	85	0	85	203	288
10/19/2014	1095.5	2493	709.0	85	0	85	203	288
10/20/2014	1095.5	2493	708.8	85	0	85	203	287
10/21/2014	1095.4	2494	708.8	85	0	85	202	287
10/22/2014	1095.3	2492	708.9	84	0	84	203	287
10/23/2014	1095.3	2495	708.9	84	0	84	202	286
10/24/2014	1095.2	2498	709.0	84	0	84	204	288
10/25/2014	1095.1	2489	708.8	84	0	84	203	287
10/26/2014	1095.1	2492	708.8	84	0	84	201	285
10/27/2014	1095.0	2502	709.1	83	0	83	203	287

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
10/28/2014	1095.0	2497	709.1	83	0	83	203	286
10/29/2014	1094.9	2499	709.1	83	0	83	204	287
10/30/2014	1094.9	2491	709.0	83	0	83	203	286
10/31/2014	1095.0	2274	709.0	83	0	83	203	286
11/1/2014	1095.0	2465	708.9	83	0	83	203	286
11/2/2014	1095.0	2465	708.9	83	0	83	203	286
11/3/2014	1094.9	2488	709.3	83	0	83	205	287
11/4/2014	1094.9	2398	709.2	83	0	83	204	286
11/5/2014	1094.9	2322	708.8	83	0	83	233	316
11/6/2014	1094.9	2380	709.2	83	0	83	203	286
11/7/2014	1095.1	2388	708.9	83	0	83	202	285
11/8/2014	1095.1	2375	709.2	83	0	83	204	287
11/9/2014	1095.1	2354	709.1	83	0	83	204	287
11/10/2014	1095.1	2394	709.0	83	0	83	204	287
11/11/2014	1095.0	2370	709.2	83	0	83	205	287
11/12/2014	1094.9	2383	709.6	83	0	83	206	288
11/13/2014	1094.9	2368	709.6	82	0	82	203	285
11/14/2014	1094.8	2385	709.3	82	0	82	202	284
11/15/2014	1094.7	2384	709.4	82	0	82	202	284
11/16/2014	1094.6	2383	709.5	82	0	82	203	285
11/17/2014	1094.5	2378	709.2	83	0	83	204	287
11/18/2014	1094.4	2383	709.6	84	0	84	206	290
11/19/2014	1094.3	2394	709.4	84	0	84	204	288
11/20/2014	1094.2	2377	709.1	83	0	83	203	286
11/21/2014	1094.1	2380	709.3	83	0	83	203	287
11/22/2014	1094.1	2381	708.9	83	0	83	203	286
11/23/2014	1094.0	2379	708.9	83	0	83	203	286
11/24/2014	1093.9	2383	709.3	83	0	83	204	287
11/25/2014	1093.9	2366	709.3	83	0	83	204	287
11/26/2014	1093.9	2382	709.0	83	0	83	203	286
11/27/2014	1093.9	2385	708.8	83	0	83	202	284
11/28/2014	1094.1	2378	708.8	84	0	84	203	287
11/29/2014	1094.2	2376	709.2	86	0	86	206	292
11/30/2014	1094.3	2370	708.8	86	0	86	205	291
12/1/2014	1094.3	2357	708.8	86	0	86	75	162
12/2/2014	1094.3	2338	708.9	86	0	86	0	86
12/3/2014	1094.3	2350	709.4	86	0	86	0	86
12/4/2014	1094.2	2383	709.7	86	0	86	0	86
12/5/2014	1094.2	2397	709.3	86	0	86	0	86
12/6/2014	1094.1	2356	709.3	86	0	86	0	86
12/7/2014	1094.1	2359	709.2	86	0	86	0	86
12/8/2014	1094.0	1760	709.2	86	0	86	0	86
12/9/2014	1094.0	1752	709.2	86	0	86	0	86
12/10/2014	1094.0	1758	708.9	86	0	86	0	86
12/11/2014	1094.1	1726	708.8	86	0	86	0	86
12/12/2014	1094.2	1745	709.0	86	0	86	0	86
12/13/2014	1094.2	2345	709.2	86	0	86	0	86
12/14/2014	1094.2	2349	709.3	86	0	86	0	86
12/15/2014	1094.2	2350	709.3	86	0	86	0	86
12/16/2014	1094.1	2353	709.5	86	0	86	0	86

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
12/17/2014	1094.1	2352	709.7	86	0	86	0	86
12/18/2014	1094.0	2354	709.8	150	0	150	0	150
12/19/2014	1094.0	2360	710.0	125	0	125	0	125
12/20/2014	1094.0	2353	709.5	83	0	83	0	83
12/21/2014	1094.0	2350	709.4	83	0	83	0	83
12/22/2014	1094.0	2350	709.3	234	0	234	0	234
12/23/2014	1093.9	2347	709.4	199	0	199	0	199
12/24/2014	1093.9	2353	709.4	98	0	98	0	98
12/25/2014	1093.8	2348	709.0	84	0	84	0	84
12/26/2014	1093.7	2344	709.2	84	0	84	0	84
12/27/2014	1093.7	2348	709.3	84	0	84	0	84
12/28/2014	1093.6	2358	709.6	83	0	83	0	83
12/29/2014	1093.5	2360	709.7	83	0	83	0	83
12/30/2014	1093.4	2360	709.6	83	0	83	0	83
12/31/2014	1093.3	2358	709.5	83	0	83	0	83

APPENDIX B: DAILY AVERAGE WATER TEMPERATURES

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
1/1/2014	N/A	4.6	4.7	4.6	4.5	4.4	5.8	4.9
1/2/2014	N/A	4.9	5.0	4.9	4.9	4.8	5.9	5.0
1/3/2014	N/A	4.9	4.8	4.9	4.8	4.7	6.0	5.1
1/4/2014	N/A	4.6	4.3	4.2	4.1	4.0	5.9	5.0
1/5/2014	N/A	4.2	4.1	3.9	3.8	3.7	5.7	4.7
1/6/2014	N/A	4.1	3.9	3.7	3.7	3.5	5.3	4.5
1/7/2014	N/A	4.3	4.2	4.1	4.1	4.0	5.4	4.5
1/8/2014	N/A	4.3	4.2	4.0	4.0	3.9	5.5	4.6
1/9/2014	N/A	4.4	4.3	4.2	4.1	4.0	5.4	4.6
1/10/2014	N/A	4.7	4.8	4.6	4.6	4.5	5.6	4.8
1/11/2014	N/A	5.2	5.4	5.6	5.5	5.5	6.0	5.2
1/12/2014	N/A	5.2	5.3	5.3	5.3	5.2	6.0	5.3
1/13/2014	N/A	5.6	5.9	6.0	6.0	6.0	6.3	5.5
1/14/2014	N/A	5.7	5.9	6.1	6.0	6.0	6.5	5.7
1/15/2014	N/A	5.6	5.6	5.8	5.7	5.6	6.7	5.8
1/16/2014	N/A	5.2	5.1	5.1	5.0	5.0	6.4	5.4
1/17/2014	N/A	5.1	5.0	5.0	5.0	4.9	6.1	5.2
1/18/2014	N/A	4.9	4.8	4.8	4.7	4.7	5.8	5.1
1/19/2014	N/A	5.1	5.1	5.0	5.0	4.9	5.9	5.2
1/20/2014	N/A	5.0	5.1	5.1	5.0	4.9	5.9	5.1
1/21/2014	N/A	4.9	4.8	4.8	4.8	4.7	5.8	5.1
1/22/2014	N/A	4.9	4.9	4.9	4.9	4.8	5.8	5.0
1/23/2014	N/A	4.9	4.9	4.9	4.9	4.8	5.8	5.0
1/24/2014	N/A	4.9	5.0	5.0	5.0	4.9	5.7	5.0
1/25/2014	N/A	4.8	4.8	4.8	4.8	4.7	5.7	5.0
1/26/2014	N/A	4.8	4.8	4.8	4.7	4.6	5.7	4.9
1/27/2014	N/A	4.8	4.9	4.9	4.9	4.8	5.6	4.8
1/28/2014	N/A	4.8	4.8	4.9	4.8	4.8	5.6	4.8
1/29/2014	N/A	4.5	4.4	4.4	4.3	4.2	5.4	4.7
1/30/2014	N/A	4.7	4.8	4.8	4.7	4.7	5.5	4.8
1/31/2014	N/A	4.7	4.6	4.8	4.7	4.6	5.5	4.7
2/1/2014	N/A	4.1	3.7	3.7	3.6	3.5	5.0	4.2
2/2/2014	N/A	3.9	3.7	3.6	3.5	3.4	4.8	4.1
2/3/2014	N/A	3.7	3.4	3.4	3.3	3.2	4.6	3.9
2/4/2014	N/A	3.5	3.1	3.1	2.9	2.8	4.6	3.7
2/5/2014	N/A	3.0	2.2	2.1	1.9	1.7	4.4	3.4
2/6/2014	N/A	2.1	1.4	1.2	1.0	0.8	3.4	2.4
2/7/2014	N/A	2.1	1.7	1.5	1.3	1.2	3.4	2.5
2/8/2014	N/A	2.5	2.2	2.0	1.9	1.7	3.6	2.7
2/9/2014	N/A	2.7	2.5	2.4	2.3	2.2	3.7	2.8
2/10/2014	2.8	2.6	2.6	2.6	2.5	2.5	3.7	2.7
2/11/2014	2.9	2.8	2.9	3.0	2.8	2.8	4.0	3.1
2/12/2014	3.5	3.4	3.9	4.0	3.9	3.9	4.6	3.5
2/13/2014	4.0	4.1	4.4	4.5	4.5	4.5	4.9	4.1
2/14/2014	4.4	4.4	4.5	4.7	4.6	4.6	5.1	4.4
2/15/2014	4.4	4.3	4.0	4.1	4.0	3.9	5.2	4.4
2/16/2014	4.3	4.3	4.6	4.6	4.5	4.5	5.2	4.3
2/17/2014	4.6	4.7	5.2	5.4	5.3	5.3	5.6	4.7
2/18/2014	4.7	4.8	4.5	4.6	4.5	4.4	5.7	4.8
2/19/2014	4.4	4.4	4.7	4.9	4.8	4.7	5.4	4.4

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
2/20/2014	4.7	4.7	4.8	4.8	4.7	4.7	5.4	4.7
2/21/2014	4.8	4.8	4.8	4.9	4.8	4.8	5.6	4.8
2/22/2014	4.9	4.8	4.6	4.6	4.5	4.5	5.7	4.9
2/23/2014	4.8	4.8	4.8	4.9	4.8	4.8	5.6	4.8
2/24/2014	4.5	4.4	4.3	4.4	4.3	4.2	5.2	4.5
2/25/2014	4.3	4.2	4.4	4.4	4.3	4.3	5.2	4.3
2/26/2014	4.5	4.4	4.7	4.7	4.7	4.6	5.3	4.5
2/27/2014	4.6	4.6	4.8	4.9	4.8	4.8	5.4	4.7
2/28/2014	4.9	4.9	5.5	5.6	5.5	5.5	5.6	4.9
3/1/2014	4.6	4.4	4.1	4.2	4.1	4.1	5.4	4.6
3/2/2014	4.2	4.1	3.9	3.7	3.7	3.6	5.1	4.2
3/3/2014	4.1	3.9	3.9	3.8	3.7	3.6	4.9	4.1
3/4/2014	4.3	4.2	4.4	4.4	4.3	4.3	5.2	4.3
3/5/2014	4.7	4.7	5.2	5.3	5.2	5.2	5.5	4.7
3/6/2014	5.2	5.3	5.8	6.1	6.0	6.0	6.0	5.2
3/7/2014	5.3	5.4	5.7	6.0	5.9	5.9	6.2	5.3
3/8/2014	5.4	5.4	5.5	5.7	5.6	5.6	6.3	5.4
3/9/2014	5.8	6.0	6.6	6.9	6.8	6.9	6.8	5.8
3/10/2014	6.4	6.6	7.2	7.5	7.4	7.5	7.3	6.5
3/11/2014	6.5	6.5	6.9	7.1	7.0	7.1	7.4	6.6
3/12/2014	6.8	6.8	7.2	7.4	7.3	7.3	7.8	6.9
3/13/2014	7.1	7.1	7.4	7.5	7.5	7.5	8.0	7.1
3/14/2014	7.4	7.4	7.8	8.1	7.6	7.6	8.4	7.4
3/15/2014	7.5	7.5	7.8	7.9	7.7	7.7	8.5	7.5
3/16/2014	7.6	7.7	7.9	8.2	7.8	7.8	8.6	7.7
3/17/2014	7.3	7.3	7.5	7.8	7.5	7.5	8.3	7.4
3/18/2014	6.9	6.8	7.3	7.4	7.0	7.0	7.9	6.9
3/19/2014	7.5	7.4	7.7	7.9	7.6	7.6	8.5	7.5
3/20/2014	7.0	6.9	7.1	7.2	7.1	7.0	8.0	7.0
3/21/2014	7.0	6.8	7.1	7.2	7.1	7.1	8.0	7.0
3/22/2014	7.0	6.9	7.0	7.1	7.1	7.1	8.0	7.0
3/23/2014	7.1	7.1	7.6	7.8	7.3	7.4	8.1	7.2
3/24/2014	7.6	7.6	8.0	8.2	7.8	7.8	8.6	7.7
3/25/2014	7.7	7.8	7.9	8.1	7.9	7.9	8.7	7.8
3/26/2014	7.8	7.9	8.2	8.5	8.0	8.0	8.8	7.9
3/27/2014	8.2	8.3	8.8	9.1	8.5	8.6	9.2	8.3
3/28/2014	8.0	7.9	7.7	7.8	8.0	7.9	9.0	8.0
3/29/2014	7.7	7.8	8.2	8.5	7.9	8.0	8.7	7.8
3/30/2014	8.0	8.0	8.5	8.6	8.2	8.2	9.0	8.0
3/31/2014	8.2	8.2	8.6	8.8	8.4	8.4	9.3	8.3
4/1/2014	8.5	8.6	9.1	9.3	8.8	8.8	9.5	8.6
4/2/2014	8.9	8.9	9.2	9.3	9.1	9.1	9.9	8.9
4/3/2014	9.1	9.2	9.2	9.4	9.3	9.2	10.1	9.2
4/4/2014	9.4	9.4	9.9	10.1	9.6	9.6	10.4	9.4
4/5/2014	9.4	9.5	9.8	10.0	9.6	9.6	10.4	9.5
4/6/2014	9.6	9.7	10.3	10.5	9.9	9.9	10.6	9.6
4/7/2014	10.1	10.3	10.9	11.2	10.4	10.5	11.0	10.2
4/8/2014	10.5	10.7	11.2	11.6	10.8	10.9	11.5	10.6
4/9/2014	10.3	10.4	10.6	10.9	10.5	10.5	11.3	10.3
4/10/2014	10.4	10.5	10.8	11.0	10.6	10.6	11.3	10.4

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
4/11/2014	11.0	11.1	11.4	11.6	11.3	11.3	12.0	11.0
4/12/2014	10.9	10.9	11.2	11.4	11.1	11.1	11.9	10.9
4/13/2014	10.9	10.9	11.2	11.4	11.1	11.1	11.7	10.9
4/14/2014	11.2	11.2	11.3	11.4	11.4	11.4	NA	11.0
4/15/2014	11.5	11.6	11.8	11.9	11.7	11.7	NA	11.3
4/16/2014	11.7	11.8	11.7	11.9	11.7	11.7	NA	11.2
4/17/2014	11.7	11.8	11.8	12.0	11.8	11.7	NA	11.2
4/18/2014	11.6	11.5	11.6	11.7	11.5	11.5	NA	11.1
4/19/2014	11.5	11.4	11.3	11.4	11.4	11.4	NA	11.0
4/20/2014	11.6	11.6	11.8	11.9	11.6	11.6	NA	11.1
4/21/2014	11.8	11.8	11.8	11.9	11.9	11.8	NA	11.3
4/22/2014	12.1	12.1	11.6	12.3	12.2	12.2	NA	11.7
4/23/2014	11.9	11.8	NA	12.2	12.0	12.1	NA	11.9
4/24/2014	11.6	11.6	NA	12.3	11.8	11.9	NA	11.7
4/25/2014	11.6	11.6	NA	12.1	11.8	11.9	NA	11.7
4/26/2014	11.8	11.7	NA	12.3	11.9	12.1	NA	11.9
4/27/2014	11.9	11.8	NA	12.3	12.0	12.1	NA	11.9
4/28/2014	11.6	11.6	NA	12.2	11.7	11.9	NA	11.7
4/29/2014	12.2	12.2	NA	12.8	12.4	12.5	NA	12.3
4/30/2014	12.9	12.9	NA	13.5	13.1	13.3	NA	13.0
5/1/2014	13.8	13.9	NA	14.5	14.0	14.2	NA	13.9
5/2/2014	14.9	15.1	NA	15.3	15.1	15.2	NA	15.0
5/3/2014	14.5	14.6	NA	14.9	14.7	14.8	NA	14.6
5/4/2014	14.1	14.2	NA	14.1	14.2	14.3	NA	14.2
5/5/2014	14.2	14.2	NA	14.4	14.3	14.4	NA	14.3
5/6/2014	14.2	14.2	NA	14.6	14.3	14.5	NA	14.3
5/7/2014	14.5	14.4	NA	14.9	14.6	14.7	NA	14.5
5/8/2014	14.7	14.7	NA	14.6	14.8	14.8	NA	14.8
5/9/2014	14.7	14.7	NA	14.7	14.8	14.8	NA	14.7
5/10/2014	14.2	14.2	NA	14.6	14.3	14.5	NA	14.3
5/11/2014	14.4	14.4	NA	14.9	14.5	14.7	NA	14.5
5/12/2014	14.7	14.7	NA	15.2	14.9	15.1	NA	14.9
5/13/2014	15.0	15.1	NA	15.7	15.4	15.5	NA	15.3
5/14/2014	15.8	15.9	NA	16.2	16.6	16.7	NA	16.1
5/15/2014	16.9	17.0	NA	17.3	17.3	17.4	NA	17.0
5/16/2014	17.7	17.8	NA	18.0	18.0	18.1	NA	17.8
5/17/2014	17.5	17.5	NA	17.5	17.5	17.5	NA	17.6
5/18/2014	17.2	17.2	NA	17.3	17.3	17.4	NA	17.3
5/19/2014	16.9	17.0	NA	17.0	17.0	17.1	NA	17.0
5/20/2014	17.0	17.0	NA	17.4	17.3	17.5	NA	17.0
5/21/2014	17.1	17.1	NA	17.4	17.4	17.5	NA	17.1
5/22/2014	17.4	17.5	NA	17.9	17.9	18.1	NA	17.5
5/23/2014	17.6	17.7	NA	17.7	17.7	17.7	NA	17.7
5/24/2014	17.2	17.3	NA	17.5	17.5	17.6	NA	17.3
5/25/2014	17.0	17.0	NA	17.1	17.1	17.2	NA	17.1
5/26/2014	16.8	16.8	NA	17.0	17.0	17.1	NA	16.9
5/27/2014	16.7	16.7	NA	16.9	16.9	17.0	NA	16.8
5/28/2014	16.5	16.5	NA	16.7	16.7	16.7	NA	16.5
5/29/2014	16.5	16.5	NA	16.7	16.7	16.8	NA	16.6
5/30/2014	16.6	16.6	NA	16.8	16.8	16.9	NA	16.6

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
5/31/2014	16.9	16.9	NA	17.1	17.1	17.2	NA	16.9
6/1/2014	17.0	17.0	NA	17.3	17.3	17.3	NA	17.1
6/2/2014	17.5	17.6	NA	17.8	17.9	17.9	NA	17.6
6/3/2014	18.0	18.1	NA	18.4	18.4	18.4	NA	18.2
6/4/2014	18.1	18.1	NA	18.3	18.3	18.4	NA	18.1
6/5/2014	18.0	18.0	NA	18.2	18.2	18.3	NA	18.1
6/6/2014	18.2	18.2	NA	18.4	18.4	18.4	NA	18.3
6/7/2014	18.0	18.0	NA	18.3	18.3	18.4	NA	18.1
6/8/2014	18.2	18.2	NA	18.5	18.5	18.6	NA	18.3
6/9/2014	18.5	18.5	NA	18.7	18.7	18.8	NA	18.5
6/10/2014	18.2	18.2	NA	18.4	18.5	18.5	NA	18.3
6/11/2014	18.2	18.3	NA	18.5	18.5	18.6	NA	18.3
6/12/2014	18.3	18.3	NA	18.5	18.5	18.6	NA	18.3
6/13/2014	17.8	17.8	NA	17.5	17.5	17.6	NA	17.9
6/14/2014	17.8	17.8	NA	18.1	18.1	18.2	NA	17.8
6/15/2014	17.8	17.8	NA	17.8	17.8	17.9	NA	17.9
6/16/2014	17.6	17.5	NA	17.1	17.1	17.1	NA	17.6
6/17/2014	17.1	17.1	NA	17.2	17.2	17.3	NA	17.1
6/18/2014	17.4	17.4	NA	17.9	17.9	18.0	NA	17.4
6/19/2014	17.7	17.7	NA	18.2	18.2	18.3	NA	17.7
6/20/2014	18.0	18.0	NA	18.3	18.2	18.3	NA	18.0
6/21/2014	17.9	17.9	NA	17.9	17.9	18.0	NA	17.9
6/22/2014	18.0	18.0	NA	18.6	18.6	18.7	NA	18.0
6/23/2014	18.0	18.0	NA	18.4	18.4	18.5	NA	18.1
6/24/2014	18.8	18.8	NA	19.0	19.0	19.0	NA	18.9
6/25/2014	19.2	19.2	NA	19.5	19.5	19.6	NA	19.3
6/26/2014	18.7	18.7	NA	19.0	19.0	19.1	NA	18.9
6/27/2014	19.1	19.2	NA	19.4	19.4	19.5	NA	19.2
6/28/2014	19.0	19.0	NA	19.2	19.2	19.2	NA	19.0
6/29/2014	19.0	19.0	NA	19.2	19.2	19.3	NA	19.1
6/30/2014	19.2	19.3	NA	19.3	19.3	19.4	NA	19.3
7/1/2014	19.5	19.6	NA	19.8	19.8	19.9	NA	19.6
7/2/2014	18.7	18.7	NA	19.6	19.6	19.7	NA	19.2
7/3/2014	19.8	19.9	NA	20.1	20.1	20.2	NA	20.0
7/4/2014	19.9	20.0	NA	20.2	20.2	20.2	NA	20.0
7/5/2014	19.9	19.9	NA	20.2	20.2	20.3	NA	20.0
7/6/2014	20.2	20.2	NA	20.7	20.7	20.8	NA	20.2
7/7/2014	20.5	20.5	NA	21.0	21.0	21.1	NA	20.6
7/8/2014	20.9	21.0	NA	21.4	21.4	21.5	NA	21.2
7/9/2014	21.3	21.3	NA	21.8	21.8	21.9	NA	21.6
7/10/2014	21.8	21.9	NA	22.0	22.0	22.1	NA	21.9
7/11/2014	21.0	20.9	NA	21.9	21.9	22.0	NA	21.5
7/12/2014	19.0	18.9	NA	20.4	20.4	20.5	NA	20.1
7/13/2014	19.0	19.0	NA	20.7	20.7	20.7	NA	20.5
7/14/2014	21.9	22.1	NA	22.5	22.5	22.6	NA	22.2
7/15/2014	22.6	22.6	NA	23.0	23.0	23.1	NA	22.7
7/16/2014	22.1	22.3	NA	23.0	23.0	23.0	NA	22.6
7/17/2014	23.4	23.4	NA	23.4	23.4	23.5	NA	23.5
7/18/2014	23.1	23.1	NA	23.0	23.0	23.1	NA	23.2
7/19/2014	22.8	22.8	NA	22.8	22.8	22.8	NA	22.8

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
7/20/2014	22.2	22.1	NA	22.1	22.1	22.1	NA	22.2
7/21/2014	21.5	21.4	NA	21.5	21.5	21.6	NA	21.5
7/22/2014	21.1	21.0	NA	21.0	21.0	21.1	NA	21.1
7/23/2014	20.7	20.6	NA	20.8	20.8	20.9	NA	20.7
7/24/2014	20.0	19.9	NA	20.1	20.1	20.1	NA	20.0
7/25/2014	20.0	19.9	NA	20.2	20.2	20.2	NA	20.0
7/26/2014	20.5	20.5	NA	21.1	21.1	21.2	NA	20.5
7/27/2014	20.5	20.5	NA	21.1	21.1	21.3	NA	21.0
7/28/2014	20.8	20.9	NA	21.7	21.6	21.8	NA	21.3
7/29/2014	21.5	21.6	NA	22.3	22.3	22.5	NA	22.1
7/30/2014	22.3	22.3	NA	22.5	22.5	22.7	NA	22.8
7/31/2014	22.8	22.9	NA	22.6	22.6	22.7	NA	23.2
8/1/2014	21.6	21.6	NA	22.3	22.3	22.4	NA	22.3
8/2/2014	22.3	22.3	NA	21.8	21.8	21.9	NA	22.6
8/3/2014	22.7	22.7	NA	22.7	22.7	22.9	NA	22.8
8/4/2014	22.3	22.4	NA	23.0	23.0	23.2	NA	22.7
8/5/2014	22.4	22.4	NA	22.4	22.3	22.5	NA	23.0
8/6/2014	23.1	23.0	NA	22.4	22.3	22.4	NA	23.1
8/7/2014	23.0	22.8	NA	22.2	22.2	22.3	NA	23.0
8/8/2014	22.9	22.7	NA	22.0	22.0	22.1	NA	22.8
8/9/2014	22.8	22.7	NA	22.2	22.5	22.5	NA	22.8
8/10/2014	22.6	22.6	NA	22.7	22.7	22.8	NA	22.7
8/11/2014	21.7	21.7	NA	22.2	22.4	22.5	NA	22.5
8/12/2014	21.2	21.3	NA	21.9	22.3	22.3	NA	22.6
8/13/2014	20.6	20.7	21.8	21.9	21.8	21.9	NA	21.7
8/14/2014	22.5	22.3	21.5	21.2	22.1	21.7	NA	22.6
8/15/2014	22.4	22.3	21.9	21.7	22.2	22.0	NA	22.5
8/16/2014	22.4	22.3	22.6	22.4	22.5	22.5	NA	22.5
8/17/2014	22.1	22.1	22.5	22.5	22.5	22.5	NA	23.0
8/18/2014	22.7	22.6	23.0	22.9	23.0	23.0	NA	23.1
8/19/2014	22.8	22.7	22.9	22.9	23.1	23.0	NA	23.2
8/20/2014	23.4	23.3	23.0	22.7	23.1	23.0	23.4	23.4
8/21/2014	23.1	23.0	22.6	22.4	22.8	22.6	23.0	23.2
8/22/2014	21.3	21.1	21.6	21.5	21.5	21.5	21.7	21.9
8/23/2014	21.2	20.9	21.4	21.0	21.1	21.0	20.9	21.3
8/24/2014	21.5	21.3	21.1	20.7	20.7	20.7	21.3	21.7
8/25/2014	21.6	21.4	21.7	21.2	21.2	21.2	21.3	21.6
8/26/2014	21.9	21.7	22.1	21.7	21.7	21.7	21.7	22.0
8/27/2014	22.4	22.3	22.7	22.3	22.4	22.4	22.3	22.4
8/28/2014	22.9	22.8	22.6	22.2	22.2	22.2	22.8	22.9
8/29/2014	22.7	22.5	21.9	21.3	21.3	21.2	22.6	22.5
8/30/2014	22.3	22.0	21.5	20.7	20.7	20.6	22.1	22.2
8/31/2014	22.0	21.7	21.5	20.7	20.8	20.7	21.8	21.9
9/1/2014	21.9	21.6	21.4	20.6	20.6	20.6	21.6	21.7
9/2/2014	21.8	21.5	21.3	20.6	20.7	20.6	21.5	21.6
9/3/2014	21.1	20.8	20.4	19.5	19.6	19.5	20.9	19.8
9/4/2014	20.9	20.6	20.7	19.9	19.9	19.9	20.8	20.9
9/5/2014	21.0	20.7	21.0	20.0	20.1	20.0	20.9	20.4
9/6/2014	21.1	20.8	21.1	20.2	20.2	20.2	21.0	20.9
9/7/2014	21.1	20.9	21.4	20.4	20.4	20.4	21.2	21.2

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
9/8/2014	21.3	21.0	21.4	20.4	20.5	20.4	21.1	21.1
9/9/2014	21.1	20.8	21.2	19.9	20.0	19.9	21.0	20.7
9/10/2014	20.5	20.1	20.3	18.8	18.9	18.8	20.4	20.5
9/11/2014	19.4	18.9	19.8	18.0	18.1	18.0	19.3	19.2
9/12/2014	19.0	18.5	19.6	17.6	17.7	17.6	18.9	18.1
9/13/2014	19.2	18.8	19.9	18.0	18.1	18.0	19.1	19.0
9/14/2014	19.4	19.0	20.6	18.5	18.5	18.4	19.5	17.7
9/15/2014	19.5	19.2	20.7	18.6	18.6	18.6	19.5	19.6
9/16/2014	19.7	19.5	21.0	19.2	19.2	19.2	19.6	19.8
9/17/2014	19.9	19.7	20.9	19.4	19.4	19.4	19.7	19.9
9/18/2014	20.0	19.9	21.2	19.6	19.6	19.6	19.9	20.0
9/19/2014	20.0	19.9	21.8	19.7	19.7	19.7	19.9	20.1
9/20/2014	20.1	20.0	20.8	19.6	19.7	19.6	20.0	20.1
9/21/2014	20.3	20.2	20.3	20.0	20.0	20.0	20.3	20.5
9/22/2014	20.2	20.2	20.3	20.1	20.1	20.1	20.0	20.2
9/23/2014	19.9	19.7	19.7	19.3	19.4	19.3	19.7	19.8
9/24/2014	19.5	19.3	19.3	18.9	18.9	18.9	19.3	19.3
9/25/2014	19.0	18.8	18.8	18.3	18.4	18.3	18.9	19.0
9/26/2014	18.6	18.4	18.8	18.2	18.2	18.2	18.6	18.7
9/27/2014	18.6	18.3	18.8	18.0	18.1	18.1	18.5	18.6
9/28/2014	18.7	18.4	19.0	18.2	18.3	18.2	18.6	18.7
9/29/2014	18.8	18.5	19.0	17.9	18.0	17.9	18.7	18.8
9/30/2014	18.5	18.1	18.5	17.4	17.5	17.4	18.4	18.5
10/1/2014	18.2	17.8	18.2	16.9	17.0	16.9	18.1	18.2
10/2/2014	17.9	17.5	18.1	16.7	16.8	16.7	17.9	17.9
10/3/2014	17.8	17.4	18.2	16.6	16.7	16.6	17.8	17.8
10/4/2014	17.7	17.3	18.3	16.5	16.6	16.4	17.7	17.7
10/5/2014	17.5	17.2	19.1	17.0	17.1	17.0	17.6	17.6
10/6/2014	17.9	17.6	19.9	17.6	17.7	17.6	17.8	17.9
10/7/2014	18.2	18.0	20.1	18.0	18.1	18.1	18.1	18.3
10/8/2014	18.3	18.1	20.0	17.7	17.7	17.7	18.3	18.4
10/9/2014	18.1	17.8	19.9	17.2	17.3	17.2	18.2	18.1
10/10/2014	17.9	17.6	19.4	17.0	17.0	16.9	17.9	18.0
10/11/2014	17.5	17.3	19.2	16.7	16.7	16.6	17.4	17.5
10/12/2014	17.2	16.8	19.1	16.0	16.0	15.9	17.1	17.2
10/13/2014	17.1	16.8	19.2	16.3	16.4	16.3	17.0	17.2
10/14/2014	17.0	16.7	19.1	16.2	16.4	16.2	16.9	17.1
10/15/2014	16.9	16.6	18.8	16.1	16.8	16.6	16.9	17.0
10/16/2014	16.5	16.1	18.3	15.3	16.3	16.1	16.6	16.5
10/17/2014	16.3	16.0	17.7	15.3	16.2	16.0	16.5	16.4
10/18/2014	16.3	16.0	17.6	15.7	16.2	16.1	16.3	16.3
10/19/2014	16.4	16.1	18.3	16.1	16.3	16.3	16.4	16.4
10/20/2014	16.4	16.1	17.9	15.6	16.3	16.1	16.5	16.4
10/21/2014	16.2	15.9	18.0	15.5	16.1	16.0	16.3	16.3
10/22/2014	16.1	15.8	18.2	15.0	15.9	15.7	16.2	16.1
10/23/2014	15.8	15.5	18.6	14.9	15.7	15.5	15.9	15.8
10/24/2014	15.4	15.1	18.3	14.2	15.2	15.0	15.5	15.4
10/25/2014	15.2	14.9	18.3	14.5	15.1	14.9	15.3	15.2
10/26/2014	14.9	14.5	18.0	13.8	14.7	14.5	15.0	14.9
10/27/2014	14.6	14.1	17.8	13.4	14.4	14.2	14.8	14.6

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
10/28/2014	14.4	14.1	17.7	13.5	14.3	14.1	14.6	14.4
10/29/2014	14.4	14.2	17.6	13.7	14.3	14.2	14.6	14.4
10/30/2014	14.5	14.3	17.5	13.9	14.4	14.3	14.6	14.5
10/31/2014	14.3	14.1	17.3	14.0	14.3	14.2	14.5	14.3
11/1/2014	14.2	13.9	17.1	13.5	14.1	14.0	14.4	14.2
11/2/2014	13.9	13.6	16.9	13.0	13.8	13.6	14.2	14.0
11/3/2014	13.9	13.6	16.8	13.0	13.8	13.6	14.1	13.9
11/4/2014	13.9	13.6	16.7	13.4	13.8	13.7	14.1	13.9
11/5/2014	13.8	13.6	16.7	13.3	13.8	13.7	14.0	13.9
11/6/2014	13.8	13.6	16.5	13.6	13.8	13.7	14.1	13.9
11/7/2014	13.6	13.3	16.2	12.7	13.5	13.3	13.8	13.6
11/8/2014	13.4	13.0	15.9	12.3	13.3	13.0	13.6	13.4
11/9/2014	13.2	12.8	15.8	12.3	13.1	12.9	13.4	13.2
11/10/2014	13.0	12.5	15.5	11.6	12.8	12.5	13.2	13.0
11/11/2014	12.4	11.8	14.9	10.2	12.0	11.7	12.6	12.4
11/12/2014	11.6	10.8	14.4	9.1	11.1	10.7	11.6	11.5
11/13/2014	11.0	10.3	14.1	8.5	10.6	10.2	10.9	11.0
11/14/2014	10.6	10.0	14.0	8.3	10.3	9.9	10.6	10.7
11/15/2014	10.4	9.8	13.9	8.2	10.1	9.7	10.4	10.4
11/16/2014	10.1	9.7	13.7	8.0	10.0	9.6	10.1	10.3
11/17/2014	10.0	9.5	13.5	8.0	9.8	9.4	10.0	10.1
11/18/2014	10.1	9.5	13.4	8.1	9.7	9.4	10.1	10.0
11/19/2014	10.0	9.6	13.5	8.6	9.8	9.6	10.1	10.1
11/20/2014	10.2	9.8	13.5	9.2	10.1	9.9	10.3	10.3
11/21/2014	10.3	9.8	13.2	8.6	10.1	9.8	10.4	10.3
11/22/2014	10.0	9.6	13.1	8.7	9.8	9.6	10.1	10.0
11/23/2014	9.8	9.4	12.9	8.5	9.7	9.4	9.9	9.9
11/24/2014	9.8	9.4	12.8	8.6	9.6	9.4	9.8	9.8
11/25/2014	9.6	9.3	12.6	8.5	9.5	9.3	9.7	9.6
11/26/2014	9.7	9.4	12.7	8.9	9.6	9.4	9.7	9.7
11/27/2014	9.7	9.5	12.6	9.3	9.7	9.6	9.8	9.8
11/28/2014	9.9	9.7	12.5	9.7	9.9	9.8	10.0	9.9
11/29/2014	9.3	8.5	11.2	6.7	8.8	8.4	9.3	9.2
11/30/2014	8.3	7.5	10.6	5.4	7.7	7.3	8.2	8.2
12/1/2014	7.6	6.9	10.6	5.2	6.2	5.8	7.5	7.6
12/2/2014	7.1	6.5	10.4	4.9	4.9	4.7	7.0	7.1
12/3/2014	7.0	6.4	10.2	5.4	5.4	5.2	6.8	7.0
12/4/2014	7.3	6.9	10.3	6.0	6.0	5.8	7.2	7.4
12/5/2014	7.5	7.1	10.3	6.6	6.6	6.4	7.4	7.5
12/6/2014	7.5	7.3	10.3	7.1	7.1	7.0	7.5	7.6
12/7/2014	7.8	7.5	10.3	7.6	7.6	7.5	7.7	7.8
12/8/2014	7.9	7.8	10.3	7.7	7.8	7.7	8.0	8.1
12/9/2014	8.0	7.9	10.3	7.8	7.9	7.8	8.1	8.2
12/10/2014	8.1	7.9	10.3	7.9	7.9	7.9	8.1	8.2
12/11/2014	8.1	7.9	10.1	7.8	7.8	7.7	8.1	8.2
12/12/2014	8.0	7.8	10.0	7.8	7.8	7.7	8.1	8.1
12/13/2014	7.9	7.6	9.8	7.4	7.4	7.3	7.9	8.0
12/14/2014	7.7	7.3	9.5	6.5	6.5	6.4	7.7	7.7
12/15/2014	7.6	7.3	9.6	6.9	7.0	6.8	7.6	7.6
12/16/2014	7.7	7.4	9.4	7.1	7.1	7.0	7.7	7.7

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
12/17/2014	7.7	7.4	9.3	7.2	7.3	7.2	7.7	7.7
12/18/2014	7.6	7.5	9.2	7.5	7.5	7.4	7.7	7.7
12/19/2014	7.6	7.5	9.1	7.5	7.4	7.4	7.6	7.7
12/20/2014	7.5	7.2	9.0	7.0	7.0	6.9	7.5	7.5
12/21/2014	7.4	7.2	8.9	7.1	7.1	7.0	7.5	7.5
12/22/2014	7.5	7.4	8.2	7.2	7.2	7.1	7.6	7.6
12/23/2014	7.5	7.4	8.1	7.4	7.4	7.3	7.5	7.6
12/24/2014	7.4	7.2	7.9	7.1	7.1	7.0	7.5	7.5
12/25/2014	7.2	6.8	7.5	6.2	6.2	6.1	7.2	7.3
12/26/2014	6.9	6.5	7.3	5.8	5.8	5.7	6.9	7.0
12/27/2014	6.8	6.4	7.3	5.9	5.9	5.8	6.7	6.8
12/28/2014	6.7	6.3	7.2	5.8	5.8	5.6	6.7	6.7
12/29/2014	6.7	6.3	7.1	5.7	5.7	5.6	6.6	6.7
12/30/2014	6.3	5.6	6.5	4.2	4.3	4.1	6.3	6.3
12/31/2014	5.8	5.1	6.3	3.8	3.9	3.7	5.7	5.8

APPENDIX C: RAMPING RATE DEVIATION REPORTS

FEDERAL ENERGY REGULATORY COMMISSION
Washington D.C. 20426

Office of Energy Projects

Project No. 637-099—Washington
Lake Chelan Hydroelectric Project
Public Utility District No. 1 of Chelan County

August 26, 2014

Ms. Michelle Smith
Public Utility District No. 1 of Chelan County
327 North Wenatchee Avenue
Wenatchee, WA 98801

Subject: June 10, 2014 ramping rate deviation

Dear Ms. Smith:

This letter is in reference to your July 14, 2014, filing with the Federal Energy Regulatory Commission (Commission) describing a ramping rate deviation that occurred at the Lake Chelan Hydroelectric Project, FERC No. 637. Article 405 of the project license[1] requires you implement an Operations Compliance Monitoring Plan,[2] which, in part, requires you to comply with the ramping rate set forth in Article 7 of the Lake Chelan Settlement Agreement.[3] Pursuant to ordering paragraph (D) of your Operations Compliance Monitoring Plan, you must report any ramping rate exceeding 2 inches per hour to the Commission within 30 days of the deviation.

You report that, on June 10, 2014, you exceeded the permitted ramping rate while ramping spill rates down from 517 to 258 cubic feet per second (cfs) over a three-hour period. Your report explains that spillway flows decreased by 100 cfs per hour, while you increased outflow from the low level outlet in order to buffer any downstream effects. As a result, the water surface elevation in Reach 4 of the Chelan River decreased

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[1] Order on Offer of Settlement and Issuing New License. 117 FERC ¶ 62,1129 (issued November 6, 2006).

[2] Order Modifying and Approving Operations Compliance and Monitoring Plan, Article 405. 62 FERC ¶ 62,152 (issued November, 30, 2007).

[3] *See* Appendix A of the project license.

by an average of 4 inches per hour during the downramping effort. You report that a misinterpretation of your spill reduction ramping rate table led to the exceedance of the maximum 2 inches per hour downramping rate.

You affirm that, despite the exceedance of ramping rate, you did not observe any adverse environmental effects. You indicate that salmonid fry had been observed approximately one month earlier, but that the fry would have grown sufficiently large to avoid shoreline margins by the date of the deviation. You also note that you conducted a snorkel survey on June 17, 2014, and that you did not observe any fry during that survey.

In an attempt to prevent similar deviations from occurring, you developed an interim reduced ramping rate spill reduction table, which you included in your filing. The interim table includes more conservative ramping rates, and you report that it has been used since June 24, 2014, yielding no similar deviations. You also indicate that you are looking into incorporating automatic spill reductions into your control system programming, to replace the manual, hourly reductions currently employed.

Based on our review of the available information, it appears that the deviation from the ramping rate requirement was the result of an unclear or inaccurate spill reduction ramping rate table. Upon becoming aware of the deviation, you took action to remedy its cause, and to prevent similar deviations from occurring in the future. You also took measures to record any environmental impacts, and no adverse impacts were observed. For these reasons, we will not consider this deviation a violation of your license; however, it will be made part of the compliance history and be taken into consideration regarding any future similar deviations from the license requirements.

Thank you for your cooperation. If you have any questions concerning this letter please contact Alicia Burtner at (202) 502-8038 or alicia.burtner@ferc.gov.

Sincerely,

Thomas J. LoVullo
Chief, Aquatic Resources Branch
Division of Hydropower Administration
and Compliance



PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

August 19, 2014

VIA ELECTRONIC FILING

Honorable Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

Re: **Lake Chelan Hydroelectric Project No. 637**
Article 405 - Operations Compliance and Monitoring Plan
Request for Clarification related to Lake Levels

Dear Secretary Bose and Deputy Secretary Davis:

The Federal Energy Regulatory Commission (Commission) issued the "Order Modifying and Approving Operations Compliance and Monitoring Plan (Plan), Article 405" on November 30, 2007.[1] The Plan satisfied the License Article 405 requirement of the "Order on Offer of Settlement and Issuing New License"[2] (License) and "Order on Rehearing"[3] for the Lake Chelan Hydroelectric Project (Project) on November 6, 2006, and April 19, 2007, respectively.

Under Ordering Paragraph (D) modifying the Plan under Article 405, Chelan PUD is required to file the following report with the Commission.

> (D) The licensee shall file a report with the Commission within 30 days of any deviation from minimum flow requirements, lake levels or ramping rates. The report shall, to the extent possible, identify the cause, severity, and duration of the incident, and any observed or reported adverse environmental impacts resulting from the incident. The report shall also include: 1) operational data necessary to determine compliance with the respective license requirements regarding minimum flows, lake levels, and ramping rates, as appropriate; 2) a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and 3)

[1] 121 FERC ¶ 62,152
[2] 117 FERC ¶ 62,129
[3] 119 FERC ¶ 61,055

comments or correspondence, if any, received from the resource agencies and others regarding the incident. Based on the report and the Commission's evaluation of the incident, the Commission reserves the right to require modifications to project facilities and operations to ensure future compliance.

Chelan PUD hereby respectfully requests clarification for the following two items regarding Ordering Paragraph (D):

1. Clarification on whether it requires a 30-day deviation reporting for minimum/maximum lake level elevations only and that target lake level elevations are different and reported annually in the lake level report.

2. Clarification on reporting minimum/maximum lake level elevation deviations. Is it based on an instantaneous reading or end-of-day, top-of-hour reading, which is the number used to report actual lake levels in the annual report and on the website.

Thank you for your consideration of this request. If you have any questions regarding these clarifications, please contact me at (509) 661-4180.

Sincerely,

Michelle Smith
Licensing and Compliance Manager
michelle.smith@chelanpud.org
(509) 661-4180



PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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July 11, 2014

VIA ELECTRONIC FILING

Honorable Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

RE: Lake Chelan Hydroelectric Project No. 637 (Project)
Report on Chelan River Water Surface Ramping Rate Deviation for Reach 4 Stream Habitat Channel

Dear Secretary Bose and Deputy Secretary Davis:

This letter is to provide you with Public Utility District No. 1 of Chelan County's (Chelan PUD) follow-up report on a Chelan River water surface ramping rate deviation that occurred on June 10, 2014, on the Chelan River. This deviation was first reported by email to the Federal Energy Regulatory Commission (FERC) Portland Office (Douglas Johnson and Erich Gaedeke) and Washington Department of Ecology (Ecology) Central Regional Office (Charles McKinney and Patricia Irle) on June 11, 2014.

License Requirement

Article 405 requires Chelan PUD to implement the instream flows, ramping rates, and tailrace flows as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the settlement agreement. The specific Chelan River water surface ramping rate requirement that is the subject of this deviation report is that, "during the period when fry may be present, ramping rates will be set at approximately two inches per hour, until biological evaluations have determined the ramping rates necessary to prevent stranding of fish in the Chelan River".

Chelan PUD issued notifications of the Chelan River water surface ramping rate deviation in accordance with FERC's Order Modifying and Approving Operations Compliance and Monitoring Plan, Article 405, issued November 30, 2007. When a ramping rate deviation occurs, Chelan PUD is required to notify FERC and Ecology of the deviation within 48 hours of the time that Chelan PUD became aware of the deviation. Following the initial notification, Chelan PUD

is required to file a report with the Commission within 30 days of any deviation from Chelan River water surface ramping rate requirements. The report shall, to the extent possible, identify the cause, severity, and duration of the incident, any observed or reported adverse environmental impacts resulting from the incident, a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and comments or correspondence, if any, received from the resource agencies and others regarding the incident.

Summary of Deviation and Environmental Effects

The Chelan River water surface ramping rate deviation occurred during the afternoon of June 10 while ramping spill down from 517 cfs to 258 cfs. Flow from the spillway, which was set at 300 cfs at the beginning of the operation, was decreased at a rate of 100 cfs per hour for three successive hours, while flow from the Low Level Outlet was increased from 211 cfs to 280 cfs during the last hour to buffer the downstream effects of the spillgate closure. Water surface elevations in the Chelan River decreased because spill was reduced. Water surface elevations measured at the Chelan River Reach 4 canal outlet structure decreased by 3.6", 4.7" and 3.8" after each of the three hourly flow adjustments, which exceeded the 2" maximum per hour ramping rate currently required in Section 3.2 of the Chelan River Biological Evaluation and Implementation Plan. Decreases in Chelan River water surface elevations are limited to 2" per hour in order to minimize potential stranding of small fish. Ramping rates are expected to be evaluated and potentially revised over time pending review of ramping rate studies. The reason the water surface decreased faster than the allowable rate is that spill was ramped down faster than planned, which was caused by a misinterpretation of a spill reduction ramping rate table.

No fish stranding or mortality is expected to have occurred as a result of this event. Recently emerged Chinook fry, which were present at high densities in the Habitat Channel on May 14, would by June 10 have grown to larger size and no longer be inhabiting the shoreline margins where stranding could occur. Also, the 3,500 cfs flows from late May - early June likely resulted in most Chinook fry moving to quieter waters downstream in the tailrace and Columbia River prior to this ramping rate deviation. No Chinook fry or steelhead fry were observed during a snorkel survey conducted on June 17. There was no steelhead spawning observed in the Reach 4 Habitat Channel in 2014, thus there would not have been any steelhead fry present.

Remedial Action

Ramping rate spill reduction tables have been used as guidance to operations personnel for several years. In this case, the initial spill reduction was initiated per the table which resulted in the first deviation. Subsequent spill reductions, at 100 cfs per hour, were due to a misinterpretation of the spill reduction table. To prevent further ramping rate deviations while developing a better method to guide operations, an interim reduced ramping rate spill reduction table was developed and implemented June 24, 2014. Original and interim maximum spill reduction ramping rate tables are shown below. The interim spill reduction ramping rate table has a slower, more conservative ramping rate than required, in order to provide an operating

margin of safety. Use of the interim spill reduction ramping rate table since June 24 has been successful in preventing further ramping rate deviations to date.

Chelan PUD is also investigating improvements to control system programming in order to automate spill reductions in incremental steps over time, rather than the hourly stair-step approach that requires manual operations.

Previous Spill Reduction Instructions and Table

Decreasing Spill Ramping Rate Restrictions

- Only reduce spill during daylight hours (to aid fish movement from potential entrapment areas).
- Except for Plant Safety and System Reliability, following are License Compliance ramping rate restrictions when reducing spill:

Chelan Hydro	
Maximum Spill Reduction Ramping Rates	
Total Spill* cfs	Ramp Rate cfs/hr
1000 < Total Spill	250
500 < Total Spill <= 1000	100
400 < Total Spill <= 500	50
220 < Total Spill <= 400	30
80 < Total Spill <= 220	20

* Total Spill = Low Level Outlet + Spill Gates

Interim Revised Spill Reduction Table Implemented June 24, 2014

Chelan Hydro	
Maximum Spill Reduction Ramping Rates	
Total Spill* cfs	Ramp Rate cfs/hr
1000 < Total Spill	200
500 < Total Spill <= 1000	50
400 < Total Spill <= 500	25
220 < Total Spill <= 400	25
80 < Total Spill <= 220	20

* Total Spill = Low Level Outlet + Spill Gates

Please contact me or Steven Hays at (509) 661-4181 should you have any questions regarding this incident.

Thank you,

Michelle Smith
Licensing & Compliance Manager
michelle.smith@chelanpud.org
(509)661-4180

Attachment: Email from Chelan PUD to FERC and Ecology, June 11, 2014

cc: FERC, Erich Gaedeke and Doug Johnson
Washington Department of Ecology, Pat Irle and Charlie McKinney
Chelan River Fishery Forum

From: Smith, Michelle
To: "Douglas Johnson"; "Erich Gaedeke"
Cc: Sokolowski, Rosana; Truscott, Keith; Hudson, Kirk; Odell, Brian; Garrison, Dan; Osborn, Jeff; Hays, Steve
Subject: Lake Chelan Project No. 637 Notification of Ramping Rate Deviation
Date: Wednesday, June 11, 2014 2:47:20 PM

Doug and Erich,

This email is to notify you of a ramping rate deviation, which occurred yesterday in the Chelan River. A formal report will be filed within 30 days. The deviation was minor and no fish stranding or mortality is expected to have occurred as a result of this event. Notification to the Washington Department of Ecology is included below.

Please let me know if you have any questions or need additional information at this time.

Thank you,

Michelle

Michelle Smith

License and Environmental Compliance Manager

Chelan County PUD

Wenatchee, WA

(509) 661-4180 (office)

(509) 668-7172 (cell)

-----Original Message-----
From: Hays, Steve
Sent: Wednesday, June 11, 2014 2:00 PM
To: 'Irle, Pat (ECY)'
Cc: 'Charlie McKinney (cmck461@ECY.WA.GOV)'; Coffin, Chris (ECY); Smith, Michelle
Subject: Lake Chelan Project No. 637 Ramping Rate Deviation

This email is to provide you notification regarding a ramping rate deviation, which occurred in the Chelan River near Chelan Falls. A detailed report will be filed within 30 days.

Since May 15, flows in the Chelan River have ranged from 202 cfs to 3,500 cfs, with the peak flows lasting from late May to early June.

Chelan River flows have been managed to accomplish refill of Lake Chelan to meet target elevations and reduce risk of high spill levels that could damage fish habitat in the Chelan River. As spring runoff has diminished the snowpack, spill flows into the Chelan River have been reduced in stages as Lake Chelan refill has progressed, with current Chelan River flows returning to approximately 200 cfs today.

The deviation occurred during the afternoon of June 10 while ramping flows from 517 cfs down to 258 cfs. Flow from the spillway, which was set at 300 cfs at the beginning of the operation, was decreased at a rate of 100 cfs per hour for three successive hours, while flow from the Low Level Outlet was increased from 211 cfs to 280 cfs during the last hour to buffer the downstream effects of the spillgate closure. Water surface elevations measured at the Chelan River Reach 4 canal outlet structure decrease by 3.6", 4.7" and 3.8" after each of the three hourly flow adjustments. Ramping rates are currently set for 2" per hour, pending review of ramping rate studies.

No fish stranding or mortality is expected to have occurred as a result of this event. Recently emerged Chinook fry, which were present at high densities in the Habitat Channel on May 14, would by June 10 have grown to larger size and no longer be inhabiting the shoreline margins where stranding could occur. Also, the 3,500 cfs flows from late May - early June likely resulted in most Chinook fry moving to quieter waters downstream in the tailrace and Columbia River prior to this ramping rate deviation. There was no steelhead spawning observed in the Reach 4 Habitat Channel in 2014, thus there would not have been any steelhead fry present.

If you have any questions or require additional information, please contact Steven Hays at (509)661-4181.

Thank you

Steven Hays

Fish and Wildlife Senior Advisor

steve.hays@chelanpud.org

(509) 661-4181

From: Smith, Michelle
To: "Douglas Johnson"; "Erich Gaedeke"
Cc: Sokolowski, Rosana; Truscott, Keith; Hudson, Kirk; Odell, Brian; Garrison, Dan; Osborn, Jeff; Hays, Steve
Subject: Lake Chelan Project No. 637 Notification of Ramping Rate Deviation
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Please let me know if you have any questions or need additional information at this time.

Thank you,

Michelle

Michelle Smith

License and Environmental Compliance Manager

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If you have any questions or require additional information, please contact Steven Hays at (509)661-4181.

Thank you

Steven Hays

Fish and Wildlife Senior Advisor

steve.hays@chelanpud.org

(509) 661-4181

APPENDIX D: CONSULTATION RECORD

Chelan PUD is providing a draft of the 2014 Annual Flow Report to the USGS and members of the CRFF and LCRF in accordance with the requirements of the FERC Order Modifying and Approving Operations Compliance and Monitoring Plan, Article 405, under Ordering Paragraph (B):

> "The licensee shall allow the resource agencies, Tribes and non-governmental organizations specified under Article 405, 30 days to provide comments and/or recommendations on their report before filing with the FERC. The filing shall include comments and/or recommendations from the consulted entities and the licensee's response to any comments. If the licensee does not adopt a recommendation, the report shall include the licensee's reasons, based on project-specific information."

The following individuals were sent draft copies for a 30 day review period.

NAME	***AGENCY***	***Comments***
Coffin, Chris	Washington State Department of Ecology	
McKinney, Charlie	Washington State Department of Ecology	
Pacheco, Jim	Washington State Department of Ecology	
Korth, Jeffrey	Washington State Department of Fish and Wildlife	
Simon, Graham	Washington State Department of Fish and Wildlife	
Maitland, Travis	Washington State Department of Fish and Wildlife	
McCoy, Gina	Washington State Department of Fish and Wildlife	
Grover Wier, Kari	United States Department of Agriculture – Forest Service	
Martinez, Alex	United States Department of Agriculture – Forest Service	
Vacirca, Richard	United States Department of Agriculture – Forest Service	
Rawhouser, Ashley	National Park Service	
Anthony, Hugh	National Park Service	
Lewis, Steve	United States Fish and Wildlife Service	
Yeager, Justin	National Marine Fisheries Services	
Towey, Bill	Confederated Tribes of the Colville Reservation	
Rose, Bob	Yakama Indian Nation	
Merkle, Carl	Confederated Tribes of the Umatilla Indian Reservation	
Goedde, Robert	City of Chelan	
Archibald, Phil	Lake Chelan Sportsman Association	
Elwell, Nick	United States Geological Survey	
Ernsberger, Tom	Washington State Parks and Recreation Commission	
Snell, Nona	Washington State Recreation and Conservation Office	
Petersen, Wai	Manson Parks and Recreation Department	
Uhlhorn, Richard	Lake Chelan Recreation Association	
O'Keefe, Thomas	American Whitewater	