2017 ANNUAL REPORT

WATER QUALITY MANAGEMENT PLAN

WELLS HYDROELECTRIC PROJECT

FERC PROJECT NO. 2149

February 2018

Prepared by:
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

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EXECUTIVE SUMMARY

The annual Water Quality Management Plan (WQMP) Report includes a summary of water quality measures carried out by Public Utility District No. 1 of Douglas County (Douglas PUD) in 2016. Actions taken were consistent with the Federal Energy Regulatory Commissiom's (FERC) license order for the Wells Hydroelectric Project (Project), and the requirements found within Appendix A (Clean Water Act section 401 Water Quality Certification [401 Certification]). The 2012 Federal energy Regulatory Commission (FERC) Order requires Douglas PUD to submit an annual WQMP report to the FERC on or before May 31st during each year of the license.

The goal of the WQMP is to protect the quality of the surface waters affected by the Wells Project with regard to the numeric criteria. Studies conducted during the relicensing process have found water quality within the Wells Project to be within compliance. Douglas PUD, in collaboration with the Aquatic Settlement Work Group (Aquatic SWG), has agreed to implement measures in support of the WQMP. Reasonable and feasible measures will be implemented in order to maintain compliance with the numeric criteria of the Washington State Water Quality Standards (WQS), Chapter 173-201A WAC. The measures presented within the WQMP (Section 4.0) are designed to meet the following objectives:

Objective 1: Maintain compliance with state WQS for Total Dissolved Gas (TDG). If non-compliance is observed, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD. In early 2017 Washington Department of Ecology (Ecology) approved Douglas PUD's Gas Abatement Plan (GAP) and issued a fish passage TDG adjustment waiver for the 2017 spill season. The final 2017 GAP required Douglas PUD to monitor TDG in the forebay and tailrace of Wells Dam throughout the entire fish passage season (April – August). Hourly forebay and tailrace TDG values were reported on Douglas PUD's public webpage (www.douglaspud.org) and the U.S. Army Corps of Engineers Water Management Division webpage and the Columbia River Data Access Real Time webpage, consistent with regional fish management agencies. The GAP also included a biological monitoring plan, which involved the collection of adult salmonids at Wells Dam and juvenile salmonids at Rocky Reach Dam when TDG at Wells Dam exceeded 125% in the tailrace during any hour.

Objective 2: Maintain compliance with state WQS for water temperature. If information becomes available that suggests non-compliance is occurring or likely to occur, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD. Water temperature monitoring in 2017 was consistent with the requirements listed in the WQMP and 401 Certification.

Objective 3: Maintain compliance with state WQS for other numeric criteria. If information becomes available that suggests non-compliance is occurring or likely to occur, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD. In 2017, no WQS identified as "other numerica criteria" were observed to be outside of compliance and as such no new measures occurred.

Objective 4: Operate the Project in a manner that will avoid, or where not feasible to avoid, minimize, spill of hazardous materials and implement effective countermeasures in the event of a hazardous materials spill; and

Objective 5: Participate in regional forums tasked with improving water quality conditions and protecting designated uses in the Columbia River basin. Consistent with the WQMP, 401 Certification, and Operating License, during calendar year 2017, Douglas PUD participated in regional forums lead by Ecology, the Sovereign Technical Team, and U. S. Army Corps of Engineers and other managers. In addition, the Wells Project was operated in a manner to minimize spill and TDG production consistent with the developed Spill Playbook and GAP.

The WQMP is intended to be compatible with other water quality management plans in the Columbia River mainstem, including Total Maximum Daily Loads (TMDL). Furthermore, the WQMP is intended to be supportive of the Habitat Conservation Plan (HCP), Bull Trout Management Plan, Pacific Lamprey Management Plan, Resident Fish Management Plan, White Sturgeon Management Plan, and Aquatic Nuisance Species Management Plan through the protection of designated uses (WAC 173-201A-600) in Project waters. The WQMP is intended to be not inconsistent with other management strategies of federal, state and tribal natural resource management agencies.

This 2017 annual report on the implementation of the WQMP includes all of the water quality compliance related activities implemented during the calendar year.

1.0 INTRODUCTION

The Water Quality Management Plan (WQMP) is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement). Collectively, these six plans are critical to direct implementation of Protection, Mitigation, and Enhancement measures (PMEs) during the term of the new license (issued November 9, 2012).

During the development of the WQMP plan, the Aquatic Settlement Work Group (Aquatic SWG) focused on management priorities for resources potentially impacted by Wells Hydroelectric Project (Project) operations. Entities that participated in the Aquatic SWG include the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), Washington Department of Ecology (Ecology), Washington State Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation), and Public Utility District No. 1 of Douglas County (Douglas PUD).

The Washington State Water Quality Standards (WQS) found at WAC 173-201A include designated uses (recreation, agriculture, domestic and industrial use, and habitat for aquatic life) and supporting numeric criteria. The WQMP is intended to address only the numeric criteria of the WQS. Aquatic life uses of the Project identified by the WQS are addressed by the five other Aquatic Resource Management Plans within the Agreement and by the measures implemented in the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP).

This management plan report summarizes the relevant resource issues and background (Section 2), identifies goals and objectives of the plan (Section 3), and describes the relevant measures (Section 4) to maintain compliance with the numeric criteria of state WQS during the term of the new license.

2.0 BACKGROUND

Section 401 of the Clean Water Act (CWA, 33 USC Chapter 26 § 1341 *et seq.*) requires that applicants for a hydroelectric project license from the Federal Energy Regulatory Commission (FERC) provide the FERC with a 401 Water Quality Certification (401 Certification) that provides reasonable assurance that the Project will comply with applicable WQS and any other appropriate requirements of state law. In Washington State, Ecology is responsible for issuing 401 Certifications. The 401 Certification for the Wells Project was issued on February 27, 2012.

2.1 Water Quality Standards

Congress passed the CWA in 1972, and designated the U.S. Environmental Protection Agency (EPA) as the administering federal agency. This federal law requires that a state's water quality standards protect the surface waters of the U.S. for beneficial or designated uses, such as recreation, agriculture, domestic and industrial use, and habitat for aquatic life. Any state WQS, or amendments to these standards, do not become effective under the CWA until they have been approved by EPA.

Ecology is responsible for the protection and restoration of Washington State's waters. Ecology establishes WQS that set limits on pollution in lakes, rivers, and marine waters in order to protect water quality and specified designated uses of such water bodies. These standards are found in WAC 173-201A.

2.1.1 Water Quality Standards for the Project

The Project includes the mainstem Columbia River above Wells Dam, one mile of the mainstem Columbia River below Wells Dam, the Methow River (up to river mile [RM] 1.5) and the Okanogan River (up to RM 15.5).

Under the 2006 WQS, the Project includes designated uses for spawning/rearing (aquatic life), primary contact recreation, and all types of water supply and miscellaneous uses. Numeric criteria to support the protection of these designated uses consist of various physical, chemical, and biological parameters including total dissolved gas (TDG), temperature, dissolved oxygen (DO), pH, turbidity, and toxins.

Unless stated otherwise in the subsections below, WQS criteria discussed in subsections 2.1.1.1 to 2.1.1.6 apply to all waters within the Project.

2.1.1.1 Total Dissolved Gas

TDG is measured as a percent saturation. Based upon criteria developed by Ecology, TDG measurements shall not exceed 110% at any point of measurement in any state water body. The WQS state that an operator of a dam is not held to the TDG standards when the river flow exceeds the seven-day, 10-year-frequency (7Q10) flood. The 7Q10 flow is the highest value of a running seven consecutive day average using the daily average flows that may be seen in a 10-year period. The 7Q10 total river flow for the Project was computed by Ecology (Pickett et al 2004) using the hydrologic record from 1974 through 1998 and a statistical analysis to develop the number from 1930 through 1998. The U.S. Geological Survey Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" was followed. The resulting 7Q10 flow at Wells Dam is 246,000 cubic feet per second (cfs).

In addition to allowances for TDG standard exceedances during natural flood flows in excess of 7Q10, the TDG criteria may be adjusted to accommodate spill to facilitate fish passage over hydroelectric dams when consistent with an Ecology-approved Gas Abatement Plan (GAP). Ecology has approved on a per application basis, an interim exemption to the TDG standard (110%) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). Dams in the Columbia and Snake rivers may be granted such an exemption. The GAP must be accompanied by fisheries management, physical, and biological monitoring plans (173-201A-200(1)(f)(ii)).

<u>Columbia and Snake River TDG Exemption</u>

On the Columbia and Snake rivers, three conditions apply to the TDG exemption. First, in the tailrace of a dam, TDG shall not exceed 125% as measured in any one-hour period during spillage for fish passage. Second, TDG shall not exceed 120% in the tailrace of a dam, as an

average of the 12 highest consecutive hourly readings in any one day (24-hour period), relative to atmospheric pressure. Third, TDG shall not exceed 115% in the forebay of the next dam downstream, also based on an average of the 12 highest consecutive hourly readings in any one day (24-hour period), relative to atmospheric pressure.

The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine passage. The TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS; NMFS 2000).

2.1.1.2 Temperature

Temperature is measured by the 7-day average of the daily maximum temperatures (7-DADMax). The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date (WAC 173-201A-020).

Under the WQS, the 7-DADMax temperature within the Columbia, Methow, and Okanogan river portions of the Project shall not exceed 17.5°C (63.5°F) (WAC 173-201A-602 and 173-201A-200(1)(c)). Additionally, the WQS contains additional supplemental temperature requirements for the Project portion of the Methow River (see Methow River Supplemental Requirements section below). When a water body's temperature is warmer than 17.5°C (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F).

When the background condition of the water is cooler than 17.5°C, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:

(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge).

(B) Incremental temperature increases resulting from the combined effect of all non-point source activities in the water body must not, at any time, exceed 2.8°C (5.04°F). Temperatures are not to exceed the criteria at a probability frequency of more than once every ten years on average.

Temperature measurements should be taken to represent the dominant aquatic habitat of the monitoring site. This typically means samples should:

(A) Be taken from well mixed portions of rivers and streams.

(B) Not be taken from shallow stagnant backwater areas, within isolated thermal refuges, at the surface, or at the water's edge.

The following guidelines on preventing acute lethality and barriers to migration of salmonids are also used in determinations of compliance with the narrative requirements for use protection established in WAC 173-201A (e.g., WAC 173-201A-310(1), 173-201A-400(4), and 173-201A-410 (1)(c)). The following site-level considerations do not, however, override the temperature criteria established for waters in WAC 173-201A-200(1)(c) or WAC 173-201A-602:

(A) Moderately acclimated (16-20°C, or 60.8-68.0°F) adult and juvenile salmonids will generally be protected from acute lethality by discrete human actions maintaining the 7-DADMax temperature at or below 22°C (71.6°F) and the 1-day maximum (1-DMax) temperature at or below 23°C (73.4°F).

(B) Lethality to developing fish embryos can be expected to occur at a 1-DMax temperature greater than 17.5°C (63.5°F).

(C) To protect aquatic organisms, discharge plume temperatures must be maintained such that fish could not be entrained (based on plume time of travel) for more than two seconds at temperatures above 33°C (91.4°F) to avoid creating areas that will cause near instantaneous lethality.

(D) Barriers to adult salmonid migration are assumed to exist any time the 1-DMax temperature is greater than 22°C (71.6°F) and the adjacent downstream water temperatures are 3°C (5.4°F) or cooler.

Methow River Supplemental Requirements

Ecology has identified water bodies, or portions thereof, which require special protection for spawning and incubation in accordance with Ecology publication 06-10-038. This publication indicates where and when the following criteria are to be applied to protect the reproduction of native char, salmon, and trout. Water temperatures are not to exceed 13°C from October 1 to June 15 in the lower Methow River including the portion within the Project boundary (up to RM 1.5).

2.1.1.3 Dissolved Oxygen

DO criteria are measured in milligrams per liter (mg/L). Under the WQS, DO measurements shall not be under the 1-day minimum of 8.0 mg/L. 1-day minimum is defined as the lowest DO reached on any given day. When a waterbody's DO is lower than the 8.0 mg/L criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L. Concentrations of DO are not to fall below 8.0 mg/L at a probability frequency of more than once every ten years on average.

DO measurements should be taken to represent the dominant aquatic habitat of the monitoring site. This typically means samples should:

(A) Be taken from well mixed portions of rivers and streams.

(B) Not be taken from shallow stagnant backwater areas, within isolated thermal refuges, at the surface, or at the water's edge.

2.1.1.4 pH

pH is defined as the negative logarithm of the hydrogen ion concentration. Under the WQS, pH measurements shall be in the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.5 units.

2.1.1.5 Turbidity

Turbidity is measured in nephelometric turbidity units (NTUs). Turbidity shall not exceed 5 NTU over background when the background is 50 NTU or less; or a 10% increase in turbidity when the background turbidity is more than 50 NTU.

2.1.1.6 Toxins

Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by Ecology.

Ecology shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate compliance with WAC 173-201-240 and to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.

Within the Project Area, specifically within the Project portion of the Okanogan River, two toxic substances are of concern: Dichloro-Diphenyl-Trichloroethane (DDT) and Polychlorinated Biphenyls (PCBs). DDT is a synthetic organochlorine insecticide that was frequently used in agriculture prior to being banned in 1972. PCBs are an organic compound that were used as coolants and insulating fluids for transformers, and capacitors. PCBs are classified as persistent organic pollutants and production was banned in the 1970s due to its high level of toxicity.

Toxic substances criteria identified in the WQS for these two substances are as follow:

(A) In freshwater, DDT (and metabolites) shall not exceed 1.1 μg/L as an instantaneous concentration at any time. Exceedance of the criteria is defined as an acute condition. DDT (and metabolites) shall not exceed 0.001 μg/L as a 24-hour average. Exceedance of the criteria is defined as a chronic condition.

(B) In freshwater, PCBs shall not exceed 2.0 μg/L as a 24-hour average. Exceedance of the criteria is defined as an acute condition. PCBs shall not exceed 0.01 μg/L as a 24-hour average. Exceedance of the criteria is defined as a chronic condition.

2.1.2 305(b) Report, 303(d) List and Total Maximum Daily Loads

Every two years, the EPA, as specified in section 305(b) of the CWA, requires Ecology to compile an assessment of the state's water bodies. Data collected from the water quality assessment are used to develop a 305(b) report. The report evaluates and assigns each water body into five categories based upon the Ecology's evaluation of the water quality parameters collected from within each water body.

Category 1 states that a water body is in compliance with the State WQS for the parameter of interest.
Category 2 states a water body of concern.
Category 3 signifies that insufficient data are available to make an assessment.
Categories 4a-4c indicates an impaired water body that does not require a Total Maximum Daily Load (TMDL) for one of three reasons:

- Category 4a indicates a water body with a finalized TMDL.
- Category 4b indicates a water body with a Pollution Control Program.
- Category 4c indicates a water body impaired by a non-pollutant (e.g., low water flow, stream channelization, and dams).

Category 5 represents all water bodies within the state that are considered impaired and require a Water Quality Implementation Plan (WQIP) (formerly TMDL). The 303(d) list consists of only water bodies with Category 5 listings.

Information presented below in subsections 2.1.2.1 to 2.1.2.6 are based upon the Draft 2008 Water Quality Assessment and candidate 303(d) list that has been finalized by Ecology and submitted to the EPA for approval.

2.1.2.1 Total Dissolved Gas

The reach of the Columbia River within the Project is on the state's 1998 303(d) list for TDG impairment (Category 5 listing). In 2004, Ecology developed a TDG TMDL (which was approved by EPA) for the mid-Columbia River and as such, this reach of the Columbia River, which includes the Project, is no longer on the 303(d) list for TDG (Category 4a).

Neither the reach of the Methow River within the Project (RM 1.5) nor the reach of the Okanogan River within the Project (RM 15.5) are listed on the 2008 303(d) list for TDG.

2.1.2.2 Temperature

The reach of the Columbia River within the Project is on the state's 2004 303(d) list for temperature impairment. The EPA has developed a draft temperature TMDL for the mainstem Columbia River, including that portion of the Columbia River contained within the Project. It is anticipated that the EPA will issue the final temperature TMDL for the Columbia River at some future date. The TMDL will address the water temperature effects of dams and other human actions, including model analyses and load allocations for mainstem hydroelectric projects including Wells Dam.

The reach of the Methow River within the Project (RM 1.5) is not on the 2008 303(d) list for temperature.

The reach of the Okanogan River within the Project (RM 15.5) is not on the 2008 303(d) list for temperature. However, reaches of the Okanogan River upstream of the Wells Project boundary are listed on the 2008 303(d) list for temperature.

2.1.2.3 DO

No part of the Project area is on the 2008 303(d) list for DO.

2.1.2.4 pH

No part of the Project area is on the 2008 303(d) list for pH.

2.1.2.5 Turbidity

No part of the Project area is on the 2008 303(d) list for turbidity.

2.1.2.6 Toxins

Neither the reach of the Columbia River within the Project nor the reach of the Methow River within the Project (RM 1.5) is on the 2008 303(d) list for toxins.

The reach of the Okanogan River within the Project (RM 15.5) is not listed on the 2008 303(d) list for toxins. In 1998, Ecology put the portion of the Okanogan River within Project boundary on the 303(d) list for 4, 4'-DDE, 4,4'-DDD, PCB-1254, and PCB 1260 concentrations above standards in edible carp tissue (Ecology 1998). In 2004, Ecology completed the Lower Okanogan River DDT and PCB TMDL (which was approved by EPA).

2.2 Project Water Quality Monitoring Results

2.2.1 Total Dissolved Gas

TDG supersaturation is a condition that occurs in water when atmospheric gasses are forced into solution at pressures that exceed the pressure of the overlying atmosphere. Water containing more than 100% TDG is in a supersaturated condition. Water may become supersaturated through natural or dam-related processes that increase the amount of air dissolved in water. Supersaturated water in the Columbia River may result from the spilling of water at Columbia River dams. The occurrence of TDG supersaturation in the Columbia River system is well documented and has been linked to mortalities and migration delays of salmon and steelhead (Beiningen and Ebel 1970; Ebel et al. 1975).

At Wells Dam, Douglas PUD has monitored TDG for compliance with state and federal water quality regulations since 1998 and more recently in support of its GAP and TDG exemption issued by Ecology for juvenile fish passage (Le 2008). Douglas PUD is required to monitor TDG in the Wells Dam forebay and tailrace area (on the Columbia River, near RM 515.6).

Douglas PUD uses Rocky Reach forebay TDG data collected by Chelan County PUD for downstream forebay monitoring compliance data.

A TDG study conducted in 2006 indicated that the current location of the TDG compliance monitoring stations are appropriate in providing representative TDG production information both longitudinally and laterally downstream of Wells Dam (EES Consulting et al. 2007). Detailed information regarding the study is provided in Section 2.3.1.2.

Since 2003, Douglas PUD has operated the Project during the juvenile fish passage season (April – August) in accordance with an Ecology-approved GAP and associated TDG exemption. TDG monitoring at Wells Dam is facilitated through the deployment of Hydrolab Minisonde probes in the center of the Wells forebay and approximately 3 miles downstream of Wells Dam. TDG data are logged every fifteen minutes, averaged (4 in an hour) and transmitted on the hour. Probes are serviced and checked monthly for accuracy and calibrated if necessary.

Levels of TDG at Wells Dam and the Rocky Reach Dam forebay that result in exceedances of the numeric criteria are most likely to occur during April through August as a result of high flows caused by either rapid snow melt or federal flow augmentation intended to aid downstream juvenile salmonid passage. Douglas PUD monitors for TDG at Wells Dam year round. Chelan County PUD monitors for TDG at Rocky Reach Dam between April 1 and August 31. High TDG values at both Wells Dam and Rocky Reach Dam resulting in exceedances are often associated with various factors including high spring flows, unit outages, and upstream Federal Columbia River Power System operations, including federal flow augmentation, resulting in water entering the Project with relatively high TDG levels. During these time periods, river conditions in the mid-Columbia River system are conducive to exceedances of the TDG criteria.

2.2.2 Temperature

Beginning in 2001, an extensive water temperature monitoring effort was initiated by Douglas PUD in order to better understand the temperature dynamics throughout the Wells Reservoir. Temperature data was collected by Douglas PUD at four locations in the Columbia River (RM 544.5, RM 535.3, RM 530.0, and RM 515.6) and at one site each on the Okanogan (RM 10.5) and Methow (RM 1.4) rivers. Data collected by Douglas PUD were collected hourly using Onset tidbit temperature loggers. Monitoring start and end dates varied from year to year but generally began in the early spring and ended in late fall. Quality assurance and control measures were implemented prior to deploying and upon retrieving temperature loggers to ensure that data collected were accurate. Due to sensor loss or sensor malfunction in some years, the availability of data at some of these monitoring locations is sporadic.

In general, 7-DAD Max temperature data indicate that the portion of the Columbia River upstream of and within the Project generally warms to above 17.5°C (WQS numeric criteria) in mid-July and drops below the numeric criteria by early October (Figure 2.2-1). Water temperatures in the Methow River upstream of the Project warm to above 17.5°C in mid-July and drop below the numeric criteria by September (Figure 2.2-2), while trends in the Okanogan River (upstream of the Project) indicate warming above 17.5°C from early June with cooling by late September (Figure 2.2-3). Maximum water temperatures typically occur in late summer (August) with temperatures below Chief Joseph Dam, the Methow River (RM 1.4), and the

Okanogan River (RM 10.5) reaching 20.0°C, 22.5°C, and 27.0°C, respectively. It is important to note that these data are representative of water temperatures as they flow into the Project. In 2006, Douglas PUD expanded the Project temperature monitoring season to cover the entire year and implemented a more frequent downloading schedule. Douglas PUD also added additional monitoring stations at the mouths of the Okanogan (RM 0.5) and Methow (RM 0.1) rivers. These have been used to model temperature and allocate the effects of Project operations on water temperatures at Wells Dam and within the Wells Reservoir as they relate to compliance with the WQS numeric criteria for temperature.[1]

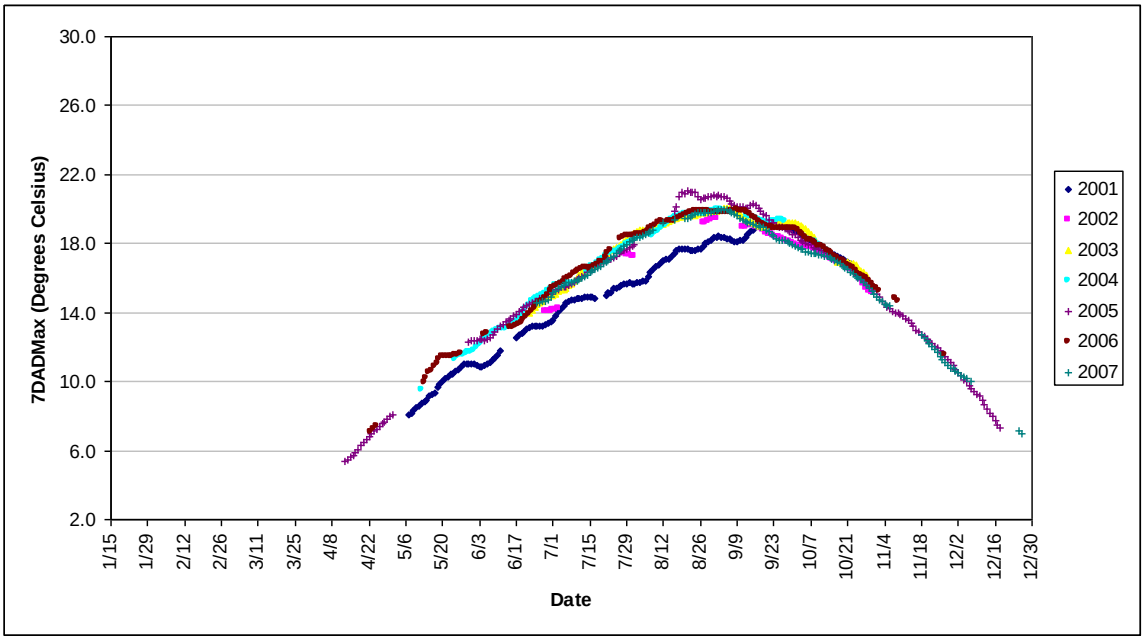

Figure 2.2-1 7-DAD Max water temperature collected in the tailrace of Chief Joseph Dam (RM 544) using Onset temperature loggers for years 2001-2007.

[1] As part of new 401 Certification requirements in 2013 Douglas PUD installed remote real time temperature loggers at boundary locations on the Wells Project, and in various other locations as required by these license requirements.

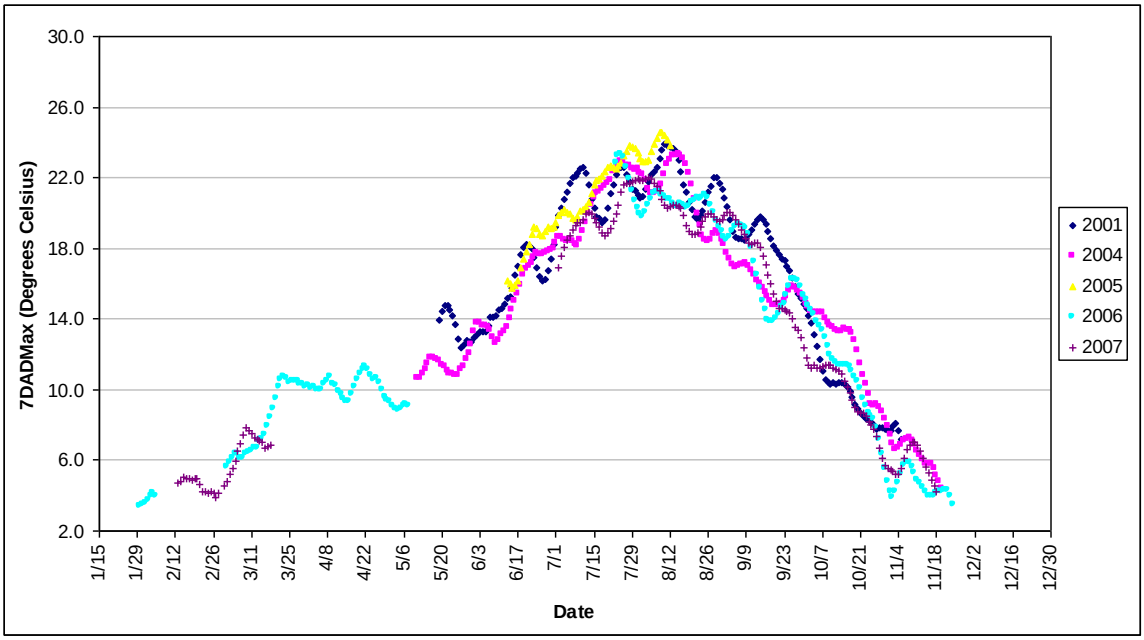

Figure 2.2-2 **7-DADMax water temperature collected in the Methow River upstream from the influence of Wells Dam (RM 1.4) using Onset temperature loggers for years 2001-2007. Data were unavailable in 2002 and 2003.**

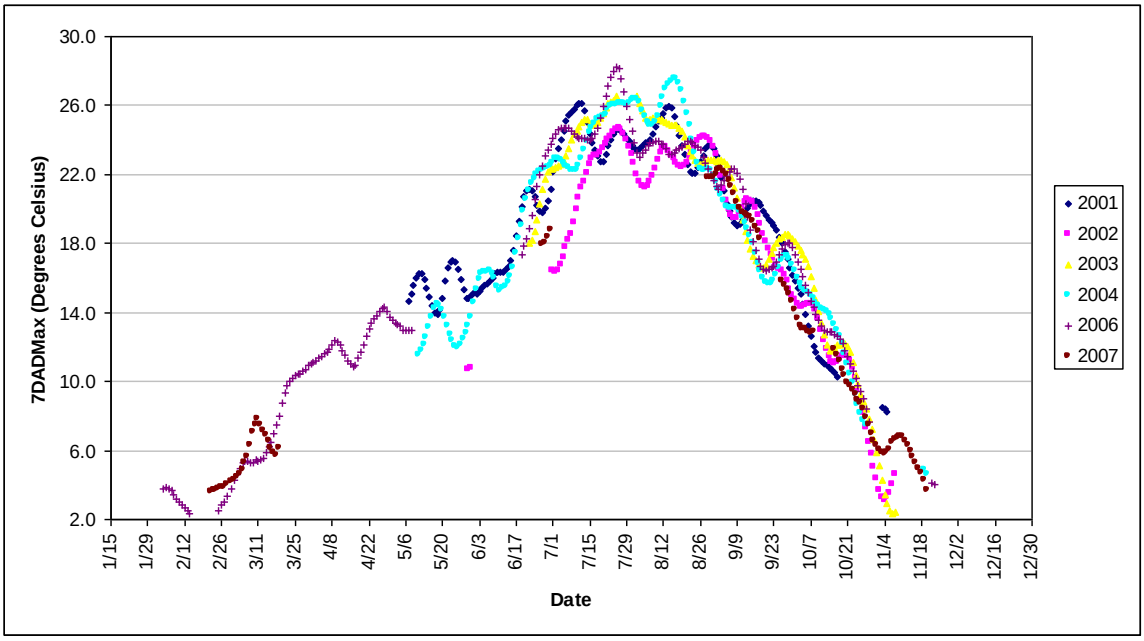

Figure 2.2-3 **7-DADMax water temperature collected in the Okanogan River (RM 10.5) using Onset temperature loggers for years 2001-2007.**

2.2.2.1 Wells Dam Fish Ladder Temperature Monitoring

Wells Dam has two fish ladders, one at each end of the dam. The two fish ladders are conventional staircase type fish ladders with 73 pools. The water source for the upper pools is the Wells Dam forebay. The flow through the upper 17 pools varies from 44 cfs at full reservoir to approximately 31 cfs at maximum reservoir drawdown. The lower 56 pools discharge a constant 48 cfs of water. To maintain the flow at 48 cfs in the lower ladder pools, supplementary water (auxiliary water supply) is introduced into Pool No. 56 through a pipeline from the reservoir. Pools are numbered in order from the bottom (near the collection gallery and entrance) to the top (exit to the Wells Dam forebay). The ladders are enclosed.

According to the HCP Biological Opinion (BO) issued by NMFS, all entities that use the fish trapping facilities at Wells Dam are required to discontinue trapping operations when fish ladder water temperatures exceed 69.8º F (21°C). In 2001 and 2003, Douglas PUD added supplemental temperature recording equipment at Pool 39 near the broodstock collection facilities in the east fishway at Wells Dam to ensure compliance with requirements in the NMFS BO. In 2001, hourly data indicated that water temperatures at this location in the east fish ladder did not exceed 69.8ºF (21°C) at any time during the monitoring period (Figure 2.2-4), which ran from late July to early December. In 2003, data were recorded every two hours (Figure 2.2-5).

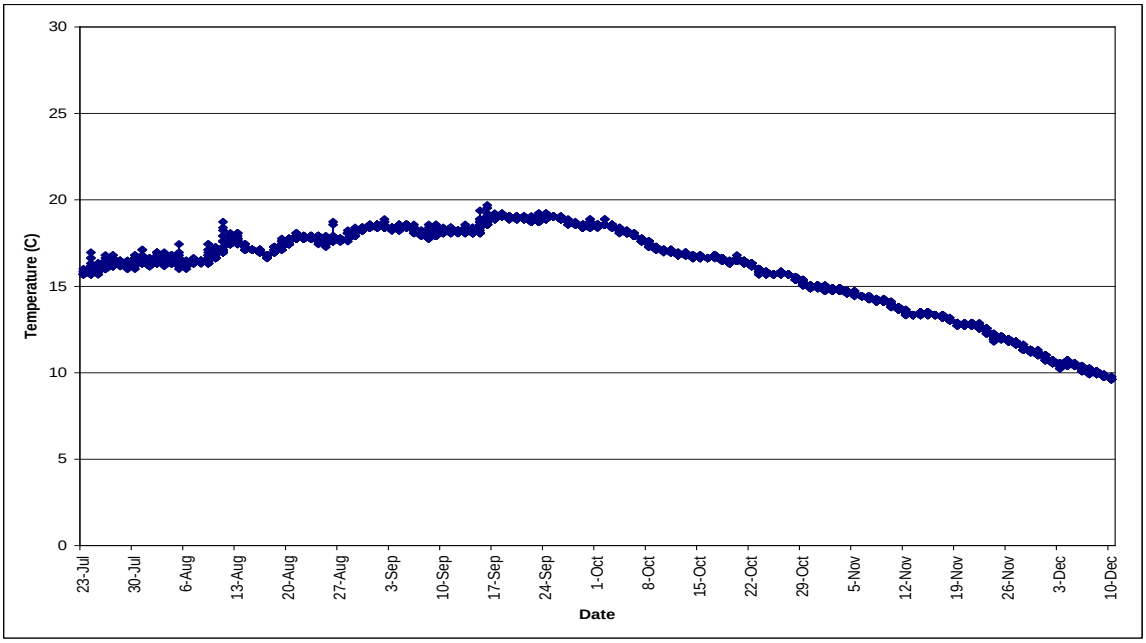

Figure 2.2-4 Hourly water temperatures collected at the Wells Dam east fish ladder trap during 2001.

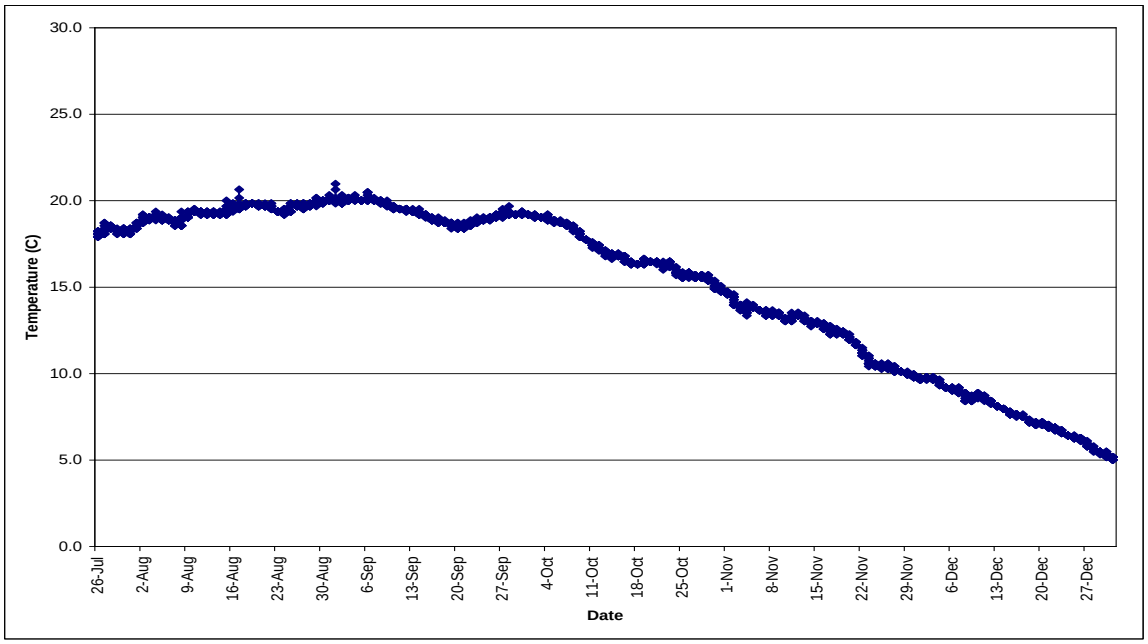

Figure 2.2-5 Water temperatures collected every two hours at the Wells Dam east fish ladder trap during 2003.

2.2.3 DO, pH, and Turbidity

2.2.3.1 DO and pH

In 2005, Douglas PUD added sensors to its existing forebay TDG monitoring equipment (Hydrolab Minisonde) in order to collect preliminary information on pH and DO within the Project to monitor these parameters during the late summer when probabilities of exceedance are highest. In 2006, Douglas PUD expanded the monitoring period to include the entire late summer period. In 2007, Douglas PUD further expanded the monitoring period to begin in July and end in early December (Figure 2.2-6 and 2.2-7). The monitoring data indicate that values for these parameters are generally in compliance with the WQS numeric criteria at this site. pH values are consistently within the range of 6.5 to 8.5 as specified by the numeric criteria. During August and September periods of this study, there were periodic excursions of DO below the numeric criteria of 8.0 mg/L. Probable causes are likely due to the physiological processes of aquatic plants; however, these exceedances do not appear to be the dominant trend.

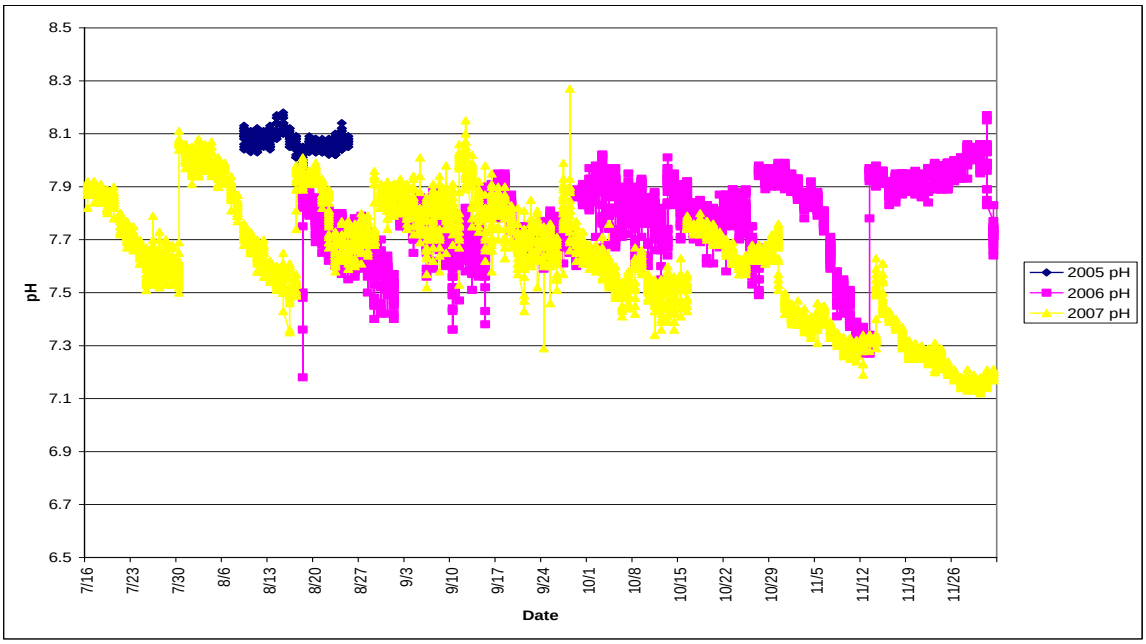

Figure 2.2-6 **pH measurements collected at the Wells Forebay TDG monitoring station (Hydrolab MiniSonde), 2005-2007.**

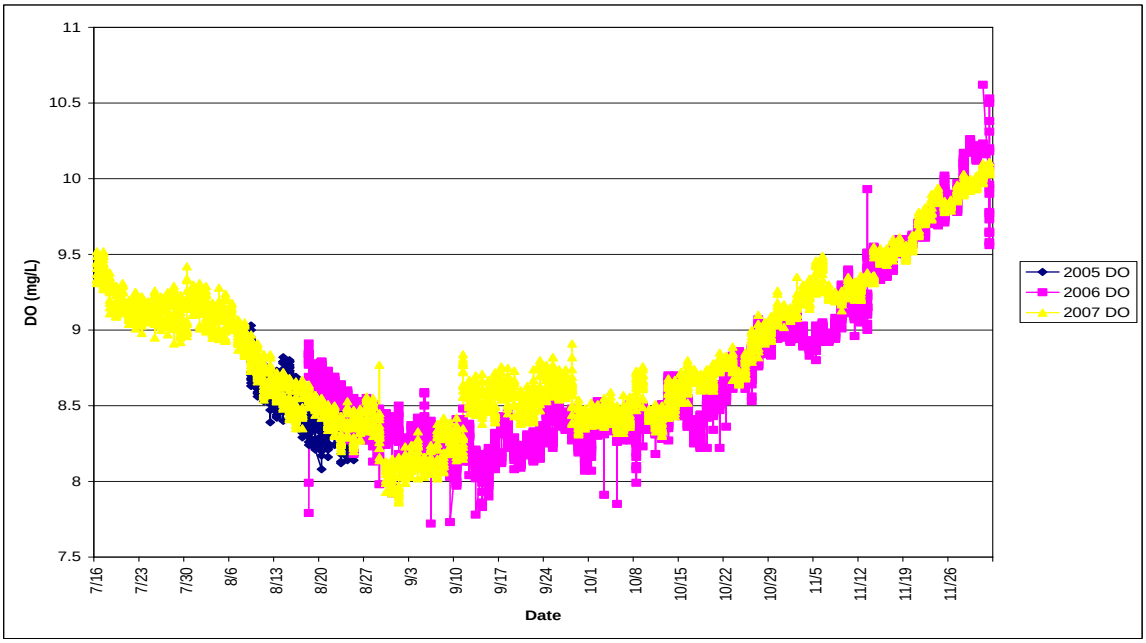

Figure 2.2-7 **DO measurements collected at the Wells Forebay TDG monitoring station (Hydrolab MiniSonde), 2005-2007.**

2.2.3.2 Turbidity

At Wells Dam, Secchi disk readings are taken daily during the adult fish passage assessment period of May 1 to November 15 to examine turbidity. A standard Secchi disk is lowered into the forebay on the west side of Wells Dam near the exit to the west fishway. Measurements are recorded in meters of visibility and records have been made since the early 1970s; however, continuous, reliable information adhering to a standard protocol has been collected since 1998. General trends of Secchi disk data suggest relatively lower periods of visibility (0.6 meters to 1.2 meters) during the spring and early summer. These relatively low periods of visibility are highly correlated with high flows during the spring runoff period. As the high flow period subsides, Secchi disk values increase to between 3.4 and 4.6 meters for the remainder of the monitoring period. In 2008, Douglas PUD installed a fixed turbidity sensor near the east fishway exit in the Wells forebay and collected turbidity data in the Wells Dam forebay.

2.3 Project Water Quality Studies

2.3.1 Total Dissolved Gas

Each year from 2003-2008, Douglas PUD implemented spill testing activities to examine the relationship between water spilled over the dam and the production of TDG. These results were subsequently used by IIHR-Hydroscience and Engineering of University of Iowa to develop and calibrate an unsteady state three-dimensional (3D), two-phase flow computational fluid dynamics (CFD) tool to predict the hydrodynamics of gas saturation and TDG distribution within the Wells tailrace. These tools were then used to reliably predict TDG production at Wells Dam and establish how preferred operating conditions and spillway configurations can be used as methods to manage TDG within WQS numeric criteria (Politano et al. 2009b).

2.3.1.1 Project TDG Assessments 2003-2005

In 2003 and 2004, Douglas PUD hired Columbia Basin Environmental (CBE) to determine the effectiveness of the tailwater sensor relative to the tailwater cross section profile for TDG and better define the relationship between spillway releases and TDG production (CBE 2003, 2004). CBE deployed TDG sensors along two transects. Based on the results of these studies, the tailwater station provided an accurate record of daily average TDG values in the Wells Dam tailrace. The studies also showed that at times, gas levels from some turbine flows were being affected by spill.

In spring 2005, Douglas PUD contracted with CBE to implement a TDG study at Wells Dam designed to measure TDG pressures resulting from various spill patterns at the dam (CBE 2006). An array of water quality data loggers was installed in the Wells Dam tailwater for a period of two weeks between May 23, 2005 and June 6, 2005. The Wells Dam powerhouse and spillway were operated through a predetermined range of operational scenarios that varied both total flow and shape of the spillway discharge. A total of eight configurations were tested including flat spill patterns (near equal distribution of spill across the entire spillway), crowned spill patterns (spill is concentrated towards the center of the spillway) and spill over loaded and unloaded units (Table 2.3-1).

Table 2.3-1 Test matrix for 2005 Wells Dam TDG Production Dynamics Study.

Test	Description
1A	Spill over load, east spill/east generation
1B	Spill over unloaded units, east spill/west generation
1C	Spill over unloaded units, west spill/east generation
1D	Spill over load, west spill/west generation
2A	Crowned spill, modest flow
2B	Dentated spill, modest flow
2C	Crowned spill, high flow
2D	Flat spill, high flow

Results from the study indicated that spill from the west side of the spillway resulted in consistently higher TDG saturations than similar spill from the east side. All dentated spill patterns and flat spill patterns at high river flow yielded higher TDG saturations than crowned spill for similar total discharges. The results of this study also indicated that TDG levels of powerhouse flows may have been influenced by spill.

2.3.1.2 EES Consulting 2006 Project TDG Production Dynamics Study

In 2006, Douglas PUD continued TDG assessments at the Project by examining the best spillway configurations and project operations to minimize the production of TDG. Douglas PUD hired a team of hydraulic and TDG experts from the Pacific Northwest to help design a monitoring program for a study that would examine various operational scenarios and their respective TDG production dynamics.

Thirteen sensors were placed along three transects at 1,000, 2,500, and 15,000 feet below Wells Dam. There were also three sensors placed across the forebay, one being the fixed monitoring station midway across the face of the dam and two more a distance of 300 feet from the dam. The sensors were programmed to collect data in 15-minute intervals for both TDG and water temperature. Each test required the operations of the dam to maintain static flows through the powerhouse and spillway for at least a three-hour period. While there were 30 scheduled spill events, there were an additional 50 events where the power house and spillway conditions were held constant for a minimum three-hour period. These "incidental" events provided an opportunity to collect additional TDG data on a variety of Project operations that met study criteria and are included in the results of the 2006 TDG Abatement Study. Spill amounts ranged from 5.2 to 52% of project flow; the volume of spill ranged from 2.2 to 124.7 kcfs and the total discharge ranged from16.4 to 254.0 kcfs. There were six tests that were done at flows that exceeded the Wells Dam 7Q10 flows of 246 kcfs.

Results of the study indicated that two operational scenarios, spread spill and concentrated spill, produced the lowest levels of TDG. The EES Consulting team recommended continued testing of operational measures to ameliorate TDG production at Wells Dam (EES Consulting et al. 2007). The 2006 study confirmed that the current locations of the forebay and tailwater TDG compliance monitoring station are appropriate in providing representative TDG production information both longitudinally and laterally downstream of Wells Dam.

2.3.1.3 IIHR-Hydroscience and Engineering TDG Modeling

A study was initiated with the University of Iowa IIHR-Hydroscience and Engineering in 2007 to develop a numerical model capable of predicting the hydrodynamics and TDG concentrations in the tailrace of the Wells Project. The purpose of the model was to assist in the understanding of the underlying dynamics of TDG production allowing an accurate evaluation of the effectiveness of various spill configurations and plant operations in reducing TDG at Wells Dam. The modeling efforts were divided into three phases. Phase I was a developmental stage for calibration and validation. The results from Phase I were successful and the model was proven to provide a reliable predictor of tailrace TDG and therefore a useful tool to identify Project operations that can minimize TDG concentrations downstream of Wells Dam (Politano et al. 2008). Phase II was a series of model runs using varying spill configurations based on typical 7Q10 events observed over the past decade. The final model run, referred to as Scenario-9, showed that preferred operating conditions and spillway configurations are able to reduce tailrace TDG to levels within Washington State WQS (< 120%) during a 7Q10 flow (Politano et al. 2009a).

Phase III included a final series of model runs aimed at gaining further reductions in tailrace TDG by reconfiguring the spillway operations used to achieve the tailrace standard in Phase II (Scenario-9). In addition to gaining additional reductions in TDG, IIHR-Hydroscience and Engineering ran a "Standard Compliance Comparison" scenario. The Standard Compliance Comparison scenario included a forebay TDG of 115%, along with 9 of 10 units operating at full capacity (i.e., 90% of total powerhouse capacity), to provide results comparable to downstream hydroelectric project TDG evaluations. The Phase III report also demonstrated compliance with two other requirements of the state WQS: (1) the ability to meet 115% in the forebay of Rocky Reach Dam during fish spill; and (2) the ability to maintain 110% in the tailrace during non-fish spill periods (Politano et al. 2009b).

2.3.1.4 Project TDG Playbooks

Since 2007, spill playbooks have been developed annually for operators at Wells Dam. The original spill playbook in 2007 focused on a range of operations to evaluate TDG production along with potential operational constraints. The subsequent playbooks evolved to the current 2012 format that simply focuses on strategies that have been identified to effectively manage TDG production in the tailrace of Wells Dam.

Since the Wells Project is a "run-of-the river" project with a relatively small storage capacity, river flows in excess of the ten-turbine hydraulic capacity must be passed over the spillways. Outside of system coordination and gas abatement spill (Douglas PUD has adopted a policy of not accepting the latter), minimization of involuntary spill has primarily focused on minimizing TDG production dynamics of water spilled based upon a reconfiguration of spillway operations. The 2009 Wells Project GAP (Lê and Murauskas, 2009) introduced the latest numerical model developed by the University of Iowa's IIHR-Hydroscience and Engineering Hydraulic Research Laboratories. The two-phase flow computational fluid dynamics tool was used to predict hydrodynamics of TDG distribution within the Wells Dam tailrace and further identify operational configurations that would minimize TDG production at the Project. In an April 2009 report, the model demonstrated that Wells Dam can be operated to meet the TDG adjustment

criteria during the passage season with flows up to 7Q-10 levels provided the forebay TDG levels are below 115%. Compliance was achieved through the use of a concentrated spill pattern through Spillbay No. 7 and surplus flow volume through adjacent odd numbered spillbays in a defined pattern and volume. These preferred operating conditions create surface-oriented flows by engaging submerged spillway lips below the ogee, thus increasing degasification at the tailrace surface, decreasing supersaturation at depth, and preventing high-TDG waters from bank attachment. These principles were the basis of the 2009 Wells Project Spill Playbook and were fully implemented for the first time during the 2009 fish passage (spill) season with success. Overall, no exceedances were observed in either the Wells Dam tailrace or the Rocky Reach forebay in 2009.

In 2010, the concepts from the 2009 Spill Playbook were integrated into the 2010 Wells Project Spill Playbook given their effectiveness in maintaining levels below TDG criteria during the previous year. High Columbia River flows in June, which exceeded the preceding 15-year average flow, resulted in several exceedances of the hourly (125% maximum) and 12C-High (120%) TDG limits in the Wells Dam tailrace, and Rocky Reach forebay (115%). In response, Douglas PUD implemented an in-season analysis of the 2010 Spill Playbook and determined that full implementation of the recommendations from IIHR Engineering Laboratory would require the removal of the juvenile fish bypass system flow barriers in one even numbered spillbay. Following the in-season analysis and consultation with the HCP Coordinating Committee, changes were made to the 2010 Spill Playbook that allowed for the removal of the juvenile fish bypass system barriers in spillbay 6. Specifically, the Spill Playbook was modified to state that when spill levels approach the 53 kcfs threshold, the JBS barriers in spillbay 6 would be removed in order to remain in compliance with the TDG criteria in the Wells Dam tailrace and Rocky Reach Dam forebay. When spill exceeded 53 kcfs, excess spill would be directed through spillbays 6 and 7 rather than through spillbays 5 and 7. This operational configuration resulted in a more compact spill pattern that reduced the air-water interface surface area between spillway flows and the subsequent potential for lateral mixing and air entrainment.

In February 2011, Douglas PUD conducted an additional technical analysis of the 2010 Spill Playbook (after in-season changes) and confirmed that continued implementation would be appropriate for 2011 with additional minor modifications. Following approval of the 2011 GAP by Ecology, the 2011 Spill Playbook was implemented. Only minor changes were made to the 2012 spill playbook as a result of high compliance during the 2011 spill season.

In December of 2012 the final GAP report was completed for the 2012 spill season. After analysis it was determined that the 2012 spill season had the third highest average monthly flows since 1969 (April- August). In addition incoming flows were reliably above 115%. Despite these conditions Wells Dam demonstrated high compliance with all standards aside from the Rocky Reach 115% 12C-high forebay standard since incoming flows to Wells were above 115% greater than 50% of the spill season days. Given these unique conditions, and high compliance performance in 2011 no changes were suggested for the 2012 spill playbook.

In summary, the resulting 2012 spill strategies are based on four basic principles:

- Spill operations concentrated through a single spillbay (as opposed to spread through several spillbays) reduce TDG production and increase degasification at the tailwater surface.

- Discharge from spillbays (denoted S hereafter) located near the middle of the dam (e.g., S7) prevent water with high TDG from attaching to the shoreline.
- Forced spill exceeding Juvenile Bypass System (JBS) flows of 2.2 kcfs must be increased to ≥ 15 kcfs to ensure that the submerged spillway lip below the ogee is engaged. The resulting force creates flows that are surface oriented, ultimately promoting degasification at the tailwater surface.
- Operations of spillbays should change with expected incoming flows, which include the removal and reinstallation of bypass barriers. Active management of the spillbays and bypass barriers should improve TDG performance.

The above principles are used as a guideline for Project operators to spill at a range of outflows to ensure the future compliance with the Washington State WQS for TDG and have been the basis for spill/bypass operations over the years of 2012-2017.

2.3.2 EES Consulting 2006 Project Limnology

In 2005, Douglas PUD implemented a study to collect baseline limnological information for waters within the Project (EES Consulting 2006). The objectives of this study were to further document existing water quality conditions within the Project and to collect information to fill water quality data gaps identified by Douglas PUD to support the water quality certification process administered by Ecology. A total of nine sampling sites, consisting of 5 mainstem sites, 2 tributaries and 2 littoral habitats, were selected to represent the spatial variability within the Project (Table 2.3-2). The year-long study began in May 2005 and investigated various water quality parameters at each of the nine sampling sites. Sampling included physical, chemical and biological water quality characteristics. A total of 22 water quality characteristics were sampled. All procedures used for the purpose of collecting, preserving and analyzing samples followed established EPA 40 CFR 136 protocol.

Table 2.3-2 Water quality sampling sites for the 2005-2006 Project Limnological Investigation.

Site	Description
1	Downstream of Chief Joseph Dam (at Hwy 17 bridge)
2	Columbia River just downstream of the Brewster Bridge
3	Bridgeport Bar littoral site
4	Columbia River downstream of Pateros where the thalweg approaches maximum depth in the lower Wells Reservoir
5	Okanogan River upstream of confluence with Columbia River
6	Methow River upstream of confluence with Columbia River
7	Lower Wells Reservoir/Starr Boat Launch littoral site
8	Wells Forebay
9	Wells Tailrace

Results from the limnological investigation showed that the Project is characterized by low to moderately low levels for nutrients, slightly basic pH (range 7.5–8.5), well-oxygenated water and low turbidity with moderately low algae growth. Average Secchi depth for the Wells Reservoir varied minimally during May through August with only a slight increase as the season

progressed (study average per site range 4.1 meters to 4.5 meters). Secchi depth (transparency) increased to a seasonal peak in September of 6.25 meters before slightly decreasing in October to a mean depth of 5.3 meters. Transparency increased downstream at the Brewster Bridge and Wells Forebay relative to the head of the reservoir at the Chief Joseph Dam tailrace for all months.

Turbidity in the Columbia River showed little seasonal variation with an annual average of 0.98 NTU and a variation of 0.38 NTU in September, 2005 (Wells Forebay site) to 3.81 NTU in February, 2006 (Brewster Bridge site). Longitudinal variation in turbidity was also minimal; sampling did not occur within the mixing zone plume of the Okanogan River. Turbidity in the Okanogan River was consistently higher than the Columbia River. Turbidity in the Methow River was higher than in the Columbia River in May (due to sediment load) and in August due to phytoplankton growth. The only turbidity reading over 5.0 NTU was in the Methow River during May where turbidity was 5.6 NTU.

Under the EES Consulting limnology study, water temperature in the Wells Reservoir is primarily governed by the temperature of inflowing water at Chief Joseph Dam with little warming occurring as water traverses the Wells Reservoir's length. Similar to the Wells hourly temperature monitoring data (Section 2.2.2), results of the study indicate that the Project waters remained unstratified throughout the entire study period and was vertically homogeneous for DO. Figure 2.3-1 shows a vertical water profile of the Project. Low respiration rates at depth, a lack of vertical stratification and short water retention times resulted in homogeneous DO levels at all depths within the Project.

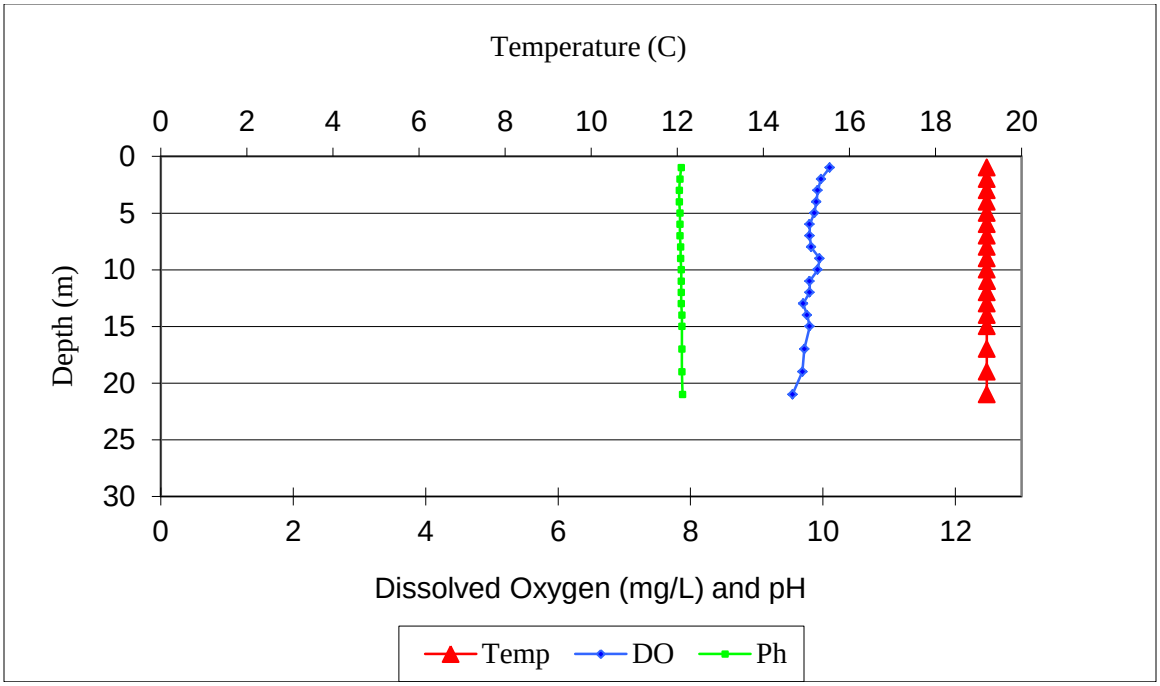

Figure 2.3-1 Vertical water quality profile of the Project forebay from sampling date August 17, 2005.

DO levels at one meter depth increased from upriver to downriver; the average difference (May through October) was 1.07 mg/L. The difference was more pronounced during May through August. The difference in September and October was 0.3 mg/L, which is at the limit of instrument reliability. Upstream to downstream differences in surface DO were negligible for the February 2006 sampling event. Littoral DO was similar or slightly higher than pelagic DO for surface waters. DO saturation levels were equal to or greater than 100% for all sites and all depths in all months except October when DO percent saturation for surface waters ranged from 110% to 91% saturation. The lower saturation levels in October may be due to reduced primary productivity while water temperatures were still relatively warm. All DO readings were above 8.0 mg/L and in compliance with the WQS numeric criteria.

Nitrogen and phosphorus are the two primary macronutrients needed for plant growth. Silica is important for diatomaceous phytoplankton. Ammonia (Nitrogen) levels were near or below detection levels for pelagic and littoral Columbia River Project waters as well as the Okanogan River for May through August and in February. Ammonia levels were only slightly higher in September and October. Ammonia peaked in the Methow River in August. Nitrates/Nitrites (Nitrogen) for Columbia River Project waters were higher in May before leveling off during the summer and fall. Nitrates/Nitrites were significantly higher at all sites for the February sample than any other month. Nitrates within littoral waters were lower than pelagic waters except in February when levels were similar. Nitrates/Nitrites in both the Okanogan and Methow rivers showed an increasing trend during the growing season. Total nitrogen levels for Columbia River pelagic and littoral waters were similar and relatively constant with the exception of significantly higher levels at most sites during February.

Orthophosphorus peaked for all stations in July. Orthophosphorus levels for pelagic and littoral waters were similar in all months except July when littoral orthophosphorus concentrations were significantly higher than observed for pelagic areas. Orthophosphorus levels in the Methow and Okanogan rivers were higher than in the Columbia River. Orthophosphorus was partially depleted in the Okanogan River but not in the Methow River at the time of the August sampling. Total phosphorus was slightly higher in littoral waters than in pelagic areas. Wave disturbance to bottom sediments may be a factor for this difference. Total phosphorus levels in pelagic surface waters ranged from below detection limits to 30.8 ug/L. Total phosphorus was higher for the Okanogan River than elsewhere, which is likely due to the higher sediment load. Total phosphorus for all stations peaked in July before gradually declining throughout the rest of the growing season.

The range in Nitrogen to Phosphorus (N:P) ratios for the Project waters was 2.5 to 30.8. The average Total Nitrogen to Total Phosphorus (TN:TP) ratio in the Project waters was 13.7 for the photic zone and averaged 14.8 for samples from all depths. These values are within the suggested literature ranges for phosphorus limitation. The N:P ratios peaked in July with pelagic and littoral waters showing similar trends. A decreasing N:P ratio through the major part of the algae growing season is typical of moderate to low nutrient waters as algae assimilate available nutrients. The N:P ratios were higher in the tributary rivers relative to the Columbia River. The N:P ratios are an indicator but not an absolute confirmation of factors limiting productivity. Moderate to low chlorophyll *a* concentrations (range 0.5 *u*g/L to 5.8 *u*g/L) occurred throughout the sample period with peaks in July and October for the Project waters. Concentrations were

lowest in August and also had the least variability among sites for the August sampling event. Pelagic and littoral waters were similar for chlorophyll *a* concentrations in most months except October when littoral waters reported twice as high *c*hlorophyll *a* levels.

Phytoplankton were dominated by diatoms for all months at all sites sampled with Chryptophyta (small unicellular flagellates) being second dominant based on biovolume. Diatoms and Chryptophyta are both considered a good food source for the rest of the aquatic food web. Diatoms comprised 75% to 84% of the total phytoplankton biomass for the Project sites. Chlorophytes (green algae) were sub-dominant in the tailrace but only a minor component elsewhere. Total phytoplankton biomass was relatively low for all Project sample sites; total biomass was generally less than 200,000 um^3/ml. Biomass peaked in July and August for pelagic areas of the Project waters and minor peaks occurred in October for littoral sites. The timing of peaks varied among all stations. Cyanophyta (blue-green algae) were only recorded in the Project sites for the July sample at Brewster Bridge where they comprised 16% of the total biomass; however, the biomass of Cyanophytes were comprised of relatively few but very large multicellular units. Cyanophytes also were recorded in the Wells Tailrace (4.7% biomass) in July. Diatoms dominated phytoplankton in the Methow River where peak biomass occurred in August (1,455,158 um^3/ml). This peak is much higher than biomass observed anywhere else in the Project. Biomass levels in the Okanogan River were only slightly higher than in the Columbia River for most months with minor peaks occurring in May and October. Cyanophytes were a small proportion of the August biomass sample for the Okanogan River.

Diatoms also dominated periphyton. Seasonal lows occurred in July for all sites except Bridgeport shallows where the trend was decreasing periphyton biovolume as the season progressed.

Zooplankton density for pelagic waters was greatest in July (6,080/m^3) and lowest (1,289/m^3) in August. Copepods dominated the zooplankton population. Zooplankton densities in the tributary river mouths peaked in May. Although rotifers were present in all months, their density dropped to very low levels after May. Cladocera were the third most prevalent group with a minor peak occurring in July for this group.

Trophic Status Index (TSI) developed by Carlson (1977, 1996) and modified for nitrogen by Kratzer and Brezonik (1981) is an indication of the productivity of a lake based on Secchi depth, TP, TN and chlorophyll *a* concentrations for summer months (June through September). Project waters are classified as oligo-mesotrophic based on a mean TSI score of 36.5 with 40 to 50 being the range for mesotrophic classification (EES 2006).

2.3.3 Okanogan River Sediment Loading Analysis

In 2006, Douglas PUD, at Ecology's request, conducted an analysis to assess sediment accumulation within the Project portion of the Okanogan River (lower 15.5 miles). The request was based upon concerns that Project operations might be contributing to the accumulation of DDT and PCB-laden sediment that could impact aquatic life designated use. Douglas PUD contracted with Erlandsen and Associates to collect bathymetric information at nine transects (RM 0.8, 1.3, 2.7, 4.9, 8.2, 10.5, 14.4, 16.6, and 19.0) within and above the Project portion of the Okanogan River. Bathymetric data of these same nine transects were collected previously by the

Bechtel Corporation in 1997. A comparison of the bathymetric data for all nine transects between 1997 and 2006 indicated that sediment is not accumulating in the Project portion of the Okanogan River. It was concluded that with regard to sediment loading, the Okanogan River is exhibiting natural riverine processes and is not affected by Project operations. Douglas PUD presented the results of the information to Ecology and the issue has been resolved.

2.3.4 Temperature, Dissolved Oxygen, pH, and Turbidity

2.3.4.1 Water Temperature Modeling

To assess compliance with the State temperature standards, two 2D laterally-averaged temperature models (using CE-QUAL-W2) were developed that represent existing (or "with Project") conditions and "without Project" conditions of the Wells Project including the Columbia River from the Chief Joseph Dam tailrace to Wells Dam, the lowest 15.5 miles of the Okanogan River, and the lowest 1.5 miles of the Methow River. The results were processed to develop daily values of the 7-DADMax, and then compared for the two conditions (West Consultants, Inc. 2008).

The model analyses demonstrated that "with Project" temperatures in the Columbia, Okanogan and Methow rivers do not increase more than 0.3^{o}C compared to ambient ("without Project") conditions anywhere in the reservoir, and that the Project complies with state water quality standards for temperature. The analyses also show that backwater from the Wells Project can reduce the very high summer temperatures observed in the lower Okanogan and Methow rivers. The intrusion of Columbia River water into the lowest 1-2 miles of the Okanogan River and lowest 1.5 miles of the Methow River can significantly decrease the temperature of warm summer inflows from upstream, and can also moderate the cold winter temperatures by 1-3^{o}C, reducing the extent and length of freezing.

2.3.4.2 Dissolved Oxygen, pH, and Turbidity

A study to collect additional DO, pH, and turbidity data from within the Wells Project was proposed by the Aquatic Resource Work Group in 2007. The goal of this study was to obtain required DO, pH, and turbidity information for the Wells Dam forebay and lower Okanogan River, both above and within the Wells Project boundary. The information gathered from these monitoring efforts demonstrated that the Project, as proposed to be operated under the new license, will meet the numeric criteria for WQS (Parametrix, Inc. 2009).

DO measurements demonstrated that the Okanogan River and the forebay of Wells Dam were in compliance with WQS. Project effects on DO concentrations in the Okanogan River were not evident as incoming water quality closely resembled that of the inundated portions of the Okanogan River. Changes in background minimum DO levels at Malott (above Project boundary) have a strong and significant linear relationship ($P < 0.0001$) with minimum values recorded within Project boundaries at both Monse and the Highway 97 Bridge. These results indicate that there is no statistically significant difference between minimum DO measurements collected above the Project and within the Project. DO concentrations in the forebay of Wells Dam remained well above the minimum numeric water quality criterion, excluding an instrument-related malfunction observed in early October (Parametrix, Inc. 2009).

Only on one occasion did pH within the Project exceed background measurements, but only by 0.06 units, well within the water quality allowance for human caused conditions. These results indicate that pH measurements within the Project boundary are well within the numeric criteria for WQS (Parametrix, Inc. 2009).

It is not clear what effect, if any, the Wells Project may have had on turbidity. Elevated turbidity values appeared to coincide with snowmelt and precipitation causing increased river flow. Turbidity levels in the Okanogan River above the Project (at Malott) were inconsistent with readings collected at both Monse (5 of 122 comparable days, or 4%) and Highway 97 (8 of 165 comparable days, or 5%), suggesting that such events are not widespread or persistent within the Wells Project (Parametrix, Inc. 2009). In 2009, Douglas PUD contracted Columbia Basin Environmental to continue monitoring turbidity for an additional year. Results from the 2009 field season indicate that turbidity decreases from the background monitoring location (Malott, RM 17.0), to both Monse (RM 5.0) and the Highway 97 Bridge (RM 1.3). No exceedances were observed and the data showed that the Wells Project is in compliance with the Washington State water quality standards for turbidity (DCPUD and CBE 2009).

2.3.5 Summary of Compliance with WQS

Based on the Initial and Updated Study Reports the Aquatic SWG was able to determine that waters within the Wells Project currently meet state numeric criteria of WQS as defined in Chapter 173-201A WAC. The following table presents supporting studies, by standard:

Standard	Studies	Result(s)	Continued Monitoring
TDG	Politano et al. 2008, 2009a, 2009b.	Compliance met under preferred operating conditions and standard compliance scenario.	Yes
Temperature	West Consultants, Inc. 2008	Compliance met, zero exceedances. Potential future TMDL.	Yes
DO	Parametrix, Inc. 2009	Compliance met, zero exceedances	No
pH	Parametrix, Inc. 2009	Compliance met, zero exceedances	No
Turbidity	Parametrix, Inc. 2009; DCPUD and CBE 2009.	Compliance met, zero exceedances	No

3.0 GOAL AND OBJECTIVES

The goal of the WQMP is to protect the quality of the surface waters affected by the Project with regard to the numeric criteria. Studies conducted during the relicensing process have found water quality within the Wells Project to be within compliance. Douglas PUD, in collaboration with the Aquatic SWG, has agreed to implement measures in support of the WQMP. Reasonable and feasible measures are being implemented in order to maintain compliance with the numeric criteria of the Washington State WQS, Chapter 173-201A WAC. The measures presented within the WQMP (Section 4.0) are designed to meet the following objectives:

Objective 1: Maintain compliance with state WQS for TDG. If non-compliance is observed, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD;

Objective 2: Maintain compliance with state WQS for water temperature. If information becomes available that suggests non-compliance is occurring or likely to occur, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD;

Objective 3: Maintain compliance with state WQS for other numeric criteria. If information becomes available that suggests non-compliance is occurring or likely to occur, the Aquatic SWG will identify reasonable and feasible measures, which will be implemented by Douglas PUD;

Objective 4: Operate the Project in a manner that will avoid, or where not feasible to avoid, minimize, spill of hazardous materials and implement effective countermeasures in the event of a hazardous materials spill; and

Objective 5: Participate in regional forums tasked with improving water quality conditions and protecting designated uses in the Columbia River basin.

The WQMP is intended to be compatible with other water quality management plans in the Columbia River mainstem, including TMDLs. Furthermore, the WQMP is intended to be supportive of the HCP, Bull Trout Management Plan, Pacific Lamprey Management Plan, Resident Fish Management Plan, White Sturgeon Management Plan, and Aquatic Nuisance Species Management Plan through the protection of designated uses (WAC 173-201A-600) in Project waters. The WQMP is intended to be not inconsistent with other management strategies of federal, state and tribal natural resource management agencies.

The schedule for implementation of specific measures within the WQMP is based on the best information available at the time the plan was developed. As new information becomes available, the measures proposed in the WQMP may be adjusted through consultation with the Aquatic SWG.

4.0 WATER QUALITY MEASURES

In order to fulfill the goals and objectives described in Section 3.0 of the WQMP, Douglas PUD, in consultation with the Aquatic SWG, has initiated the implementation of the following measures.

4.1 TDG Compliance (Objective 1)

4.1.1 Monitoring

Douglas PUD shall continue to maintain fixed monitoring stations in the forebay and tailrace area of Wells Dam to monitor TDG and barometric pressure. TDG will be monitored hourly during the fish spill season each year. Data from the Wells forebay and tailrace stations will be transmitted on a daily basis to the applicable web-accessible database used by Ecology and regional fish management agencies. Douglas PUD shall maintain this monitoring program consistent with activities described in the then-current Wells GAP (Section 4.1.3).

Douglas PUD shall provide an annual report of all spill (and predicted TDG levels in the tailrace) occurring outside the fish passage season (currently October 1 to March 15).

4.1.1.1 *Progress Towards Meeting Objective 1 in 2017 - Monitoring*

In February 2012 Ecology issued a 401 Certification for Wells Dam, consistent with Federal Power Act Requirement for licensing non-federal hydro-projects. Requirements in the 401 Certification are consistent with the WQMP. In November 2012 the FERC issued a new license for the Wells Project. Requirements in the license are consistent with the 401 Certification and the WQMP.

In early 2017 Ecology approved Douglas PUD's GAP and issued a fish passage TDG adjustment for the 2017 bypass season. Douglas PUD submitted the 2017 GAP to the FERC. FERC subsequently approved the submitted GAP in April 2017. The final 2017 GAP required Douglas PUD to monitor TDG in the forebay and tailrace of Wells Dam throughout the entire fish passage season (April – August). Hourly forebay and tailrace TDG values were reported on the U.S. Army Corps of Engineers Water Management Division webpage and the Columbia River Data Access Real Time webpage, consistent with regional fish management agencies. In addition, data was made available in realtime at www.douglaspud.org in accordance with 401 Certification requirements. Douglas PUD provided Ecology and the Aquatic SWG in-season reports on water quality. Following the completion of the calendar year, and consistent with 401 Certification requirements, Douglas PUD prepared a 2017 GAP/TDG report. The GAP report was approved by Ecology and the ASWG and filed with the FERC in February 2018, consistent with FERC license requirements.

4.1.2 Spill Operations

Within one year of issuance of the new license, Douglas PUD shall coordinate the annual HCP Project Fish Bypass/Spill Operations Plan with the Aquatic SWG and the GAP, using best available information to minimize the production of TDG during periods of spill. All operations

identified within the plan shall require the approval of the Wells HCP Coordinating Committee and the Aquatic SWG in order to ensure that spill operations are aimed at protecting designated uses and complying with the WQS numeric criteria for TDG in the Columbia River at the Project. In consultation with the Wells HCP Coordinating Committee and Aquatic SWG, the spill operations plan will be reviewed and updated, as necessary.

4.1.2.1 *Progress Towards Meeting Objective 1 in 2017 - Spill Operations*

In early 2017 Douglas PUD developed a 2017 GAP concomitantly with the 2017 Spill and Bypass Operations Plan and coordinated the review of these two documents with the HCP Coordinating Committee. Both plans were filed with the FERC after being approved by Ecology, the NMFS and the USFWS. In April 2017 the FERC approved the Juvenile Fish Bypass Plan and the Gas Abatement Plan and Spillway Play Book for 2017.

4.1.3 Project Gas Abatement Plan and TDG Exemption

Pending Ecology's approval of each subsequent GAP (which provides for the TDG exemption), Douglas PUD shall continue to implement the activities identified within the previously-approved plan. Douglas PUD shall submit the GAP to Ecology by February 28th of each year, or on a less frequent basis, as documented by Ecology in writing. Douglas PUD shall submit the GAPs through the term of the new license or until no longer required by Ecology.

The GAP will include the Spill Operations Plan (Section 4.1.2) and will be accompanied by a fisheries management plan and physical and biological monitoring plans. The GAP shall include information on any new or improved technologies to aid in the reduction in TDG.

It is anticipated that: (1) the TDG monitoring activities described in Section 4.1.1 will be adequate for the physical monitoring plan requirement; and (2) the Wells HCP and Aquatic Resource Management Plans in the Aquatic Settlement Agreement with respect to fish passage will be adequate for fish management plans, for the purposes of the GAP. Additional biological monitoring studies for purposes of Gas Bubble Trauma Monitoring may be required.

Douglas PUD shall provide an annual TDG report as required by the Ecology-approved GAP.

4.1.3.1 *Progress Towards Meeting Objective 1 in 2017 - Project Gas Abatement Plan and TDG Exemption*

In 2017, Douglas PUD implemented the Aquatic SWG and Ecology approved 2017 GAP. The GAP was submitted to, and approved by, Ecology prior and the FERC . The 2017 GAP included Douglas PUD's Spill Playbook for 2017 (Playbook), which serves as the Spill Operations Plan identified above. The Playbook is consistent with methods used at Wells to minimize the production of TDG during differing flow regimes up to 246.0 kcfs of river flow. Additional details of spill and TDG performance were provided in the 2017 GAP Report filed with Ecology and the FERC in February 2018.

The GAP also included a biological monitoring plan, which involved the collection of adult salmonids at Wells Dam and juvenile salmonids at Rocky Reach Dam when TDG at Wells Dam exceeded 125% in the tailrace during any hour.

4.1.4 Measures to Address Non-Compliance

Douglas PUD shall report all occurrences of non-compliance with TDG numeric criteria immediately to Ecology for regulatory discretion and to the Aquatic SWG for consideration.

If the Project is found to be consistently out of compliance with TDG at any time during the new license term, Douglas PUD shall, in coordination with the Aquatic SWG, take the following steps:

(A) Evaluate any new reasonable and feasible technologies that have been developed; and

(B) After the evaluation, if no new reasonable and feasible improvements have been identified, propose an alternative to achieve compliance with the standards, such as site-specific criteria, a use attainability analysis, or a water quality offset.

4.1.4.1 *Progress Towards Meeting Objective 1 in 2017- Measures to Address Non-Compliance*

During the 2017 water year, Ecology was updated regularly when flows were exceptionally high and when TDG standards exceeded those required by the fish passage TDG exemption. In addition, Douglas PUD provided Ecology regular TDG and water reports.

In consultation with Ecology and the Aquatic SWG, Douglas PUD addressed both (A) and (B) above through the development of a Quality Assurance Project Plan (Douglas PUD., 2013a) for TDG and water temperature and a Water Quality Attainment Plan (Douglas PUD., 2013b). Both Plans were developed in 2013 as a requirement of the Wells Project 401 Certification and article 401(a) in the FERC license order for Wells Dam. The plans are specifically designed to determine if the Wells Project is in compliance for TDG and what measures will be used to improve or address compliance concerns. Both plans were completed prior to October 31st 2013.

4.2 Water Temperature Compliance (Objective 2)

4.2.1 Monitoring

Douglas PUD shall continue to monitor temperature at the Wells Dam forebay and tailrace in conjunction with its TDG monitoring program (currently April 1-September 15). Temperature data from the TDG monitoring program will be recorded hourly and reported daily to regional databases. Water temperatures shall also be monitored at all boundary conditions of the Project (Methow River RM 1.5, Okanogan River RM 10.5, and Columbia River RM 544.5) and in the Well Dam forebay and tailrace as required by the Aquatic SWG.

Douglas PUD shall continue to collect hourly fish ladder temperatures 24 hours a day during the fish passage season (May 1 to November 15) at Pool No. 39 on the east ladder. Water

temperatures shall also be monitored hourly in the auxiliary water supply system and near the east shore of the Wells Dam forebay (bottom, middle, and surface depths) during this same time period.

4.2.1.1 *Progress Towards Meeting Objective 2 in 2017 - Monitoring*

Water temperature monitoring in 2017 was consistent with new requirements found in the Wells Project 401 Certification. Consistent with 401 Certification requirements Douglas PUD collected real time water temperature data in boundary locations and at Wells Dam. Data was made available at dcpud.org in real time. Additional information on monitoring is contained within the Quality Assurance Project Plan (QAPP) filed and approved by the FERC in 2013. Monitoring is consistent with the WQMP, the Wells Project 401 Certification and the Wells Dam Operating License issued by the FERC. In May of 2017 Douglas PUD submitted an annual Water Temperature Report to Ecology and the FERC describing the monitoring that occurred during the calendar year 2016. The 2017 water temperature report is attached to this WQMP at Exhibit A. Prior to May 2016 the Water Temperature report was filed with FERC each year during the month of April, however, FERC modified the Annual Water Temperature Report Deadline in 2016 to be consistent with other required reporting having a date of May 31 of each year.

4.2.2 Temperature TMDL Development and Implementation

Douglas PUD shall participate in EPA Region 10's water temperature TMDL development for the U.S. portion of the Columbia River, in coordination with the Parties of the Aquatic SWG. Temperature data from the monitoring program at Wells Dam (Section 4.2.1) and software and results of the CE-QUAL-W2 model will be made available to EPA and other entities to assist in the development of the Columbia River temperature TMDL.

Where the measures identified in the TMDL are more protective than other measures in this plan, provisions of the temperature TMDL and implementation plans relevant to the Project and its operations, including specified time frames for implementing improvement measures, shall be implemented at the Project.

If a TMDL is not timely approved by EPA, Ecology may establish an allocation. In this case, Ecology will work with the Aquatic SWG and other interested parties to identify reasonable and feasible measures.

This plan does not exclude the option of the Aquatic SWG to consider modifying the water quality standard through a use attainability analysis or other process.

4.2.2.1 *Progress Towards Meeting Objective 2 in 2017 - Temperature TMDL Development and Implementation*

No TMDL planning took place in 2017. When the EPA's TMDL development occurs, Douglas PUD will participate.

4.2.3 Measures to Address Non-Compliance

Douglas PUD shall report information indicative of non-compliance with water temperature immediately to Ecology for regulatory discretion and to the Aquatic SWG for consideration. Such information may include changes in Project operations likely to increase water temperature or observations inconsistent with related environmental parameters.

If the Project is found to be consistently out of compliance with water temperature at any time during the new license term, Douglas PUD shall, in coordination with the Aquatic SWG, take the following steps:

(A) Evaluate alternative Project operations or any new reasonable and feasible technologies that have been developed; and

(B) After the evaluation, if no new reasonable and feasible improvements have been identified, propose an alternative to achieve compliance with the standards, such as site-specific criteria, a use attainability analysis, or a water quality offset.

4.2.3.1 *Progress Towards Meeting Objective 2 in 2017 - Measures to Address Non-Compliance*

No issues of non-compliance with the state's water temperature standards were observed during 2017. As a result, no new measures are proposed to address non-compliance of the water temperature standards.

4.3 Compliance with Other Numeric Criteria (Objective 3)

Douglas PUD shall report information indicative of non-compliance with other numeric criteria immediately to Ecology for regulatory discretion and to the Aquatic SWG for consideration. This includes existing or developed criteria for toxic substances in water or sediments within Project Boundaries. The Aquatic SWG shall evaluate the information, and, if needed, require Douglas PUD to develop a plan to identify and address Project-related impacts, if any.

After the evaluation, if no reasonable and feasible improvements have been identified, Douglas PUD may propose an alternative to achieve compliance with the standards, such as site-specific criteria, a use attainability analysis, or a water quality offset.

4.3.1.1 *Progress Towards Meeting Objective 3 in 2017 - Compliance with Other Numeric Criteria*

In 2017, no other numeric criteria concerns were observed in the Project Area.

4.4 Spill Prevention and Control (Objective 4)

4.4.1 Spill Prevention and Control Requirements

Douglas PUD shall operate the Project in a manner that will minimize spill of hazardous materials and implement effective countermeasures in the event of a hazardous materials spill.

The Project Spill Prevention Control and Countermeasures Plan (SPCC) will be updated pursuant to FERC requirements and recommendations as provided by Ecology. Douglas PUD shall comply with the updated version(s) of the SPCC.

4.4.1.1 *Progress Towards Meeting Objective 4 in 2017 - Spill Prevention and Control Requirements*

The Wells Project is operated in strict compliance with the Spill Prevention and Control requirements of the WQMP, 401 Certification and the FERC license. No spill events occurred during 2017.

4.4.2 Participation in the Columbia and Snake River Spill Response Initiative

Douglas PUD shall continue participation in the Columbia and Snake River Spill Response Initiative (CSR-SRI). The CSR-SRI is a collaborative effort made up of local, state, and federal oil spill response community as well as members of industry and was developed to address the immediate need for oil spill preparedness and response in the area along the Columbia and Snake rivers. In addition to participation in the CSR-SRI, Douglas PUD shall continue to operate the Project in accordance with its SPCC (Jacobs 2007).

4.4.2.1 *Progress Towards Meeting Objective 4 in 2017 - Participation in the Columbia and Snake River Spill Response Initiative*

Douglas PUD has been an active participant in the Snake-Columbia Spill Response Initiative toward the minimization of TDG throughout the Columbia and Snake rivers. The project continues to be operated in a manner that is consistent with the SPCC (2007).

4.4.3 Inspections

For the term or the new license, Douglas PUD shall, upon reasonable notice, allow Ecology staff or representatives access to inspect the Project, including inside the dam, for the purpose of assessing Spill Prevention and Control measures and compliance with Section 4.4.1. Following inspection, Douglas PUD shall address oil and hazardous material prevention and control issues identified by Ecology.

4.4.3.1 *Progress Towards Meeting Objective 4 in 2017 - Inspections*

Douglas PUD allows access to the Project as required and as requested by Ecology. No Ecology inspection occurred in 2017.

4.5 Regional Forums (Objective 5)

4.5.1 Participation in Regional Water Quality Forums

Douglas PUD shall continue its participation in both the Water Quality Team and Adaptive Management Team meetings to address regional water quality issues, including sharing the results from monitoring, measuring, and evaluating water quality in the Wells Project. However,

Douglas PUD will not advocate for any water quality measures in regional forums without consulting with the Aquatic SWG.

4.5.1.1 *Progress Towards Meeting Objective 5 in 2017 - Participation in Regional Water Quality Forums*

Consistent with the WQMP, 401 Certification, Operating License, during calendar year 2017, Douglas PUD participated in regional forums lead by the Washington Department of Ecology, the Sovereign Technical Team, and U. S. Army Corps of Engineers and other agencies. Examples included the Mid-Columbia spring operation meeting in East Wenatchee, Washington in the spring of 2017, and the U.S. Army Corps of Engineers annual TDG monitoring meeting in Portland, Oregon in the winter of 2017. Douglas PUD will continue to participate in regional forums in 2018.

4.5.2 Project Operations

Douglas PUD may, following notice and opportunity for hearing, coordinate the operation of the project, electrically and hydraulically, with other mid-Columbia hydroelectric operations to the extent practicable. Coordinated operations are intended to reduce spill, increase generating efficiencies and thereby reduce the potential for exceedances of the TDG numeric criteria. These coordinated operations should be beneficial to TDG compliance and Aquatic Resources.

4.5.2.1 *Progress Towards Meeting Objective 5 in 2017 - Project Operations*

The Hourly Coordination Agreement expired in June of 2017. Since then, Douglas PUD receives discharges estimates from BPA for the immediately upstream project, Chief Joseph Dam, and these estimates include values for the next day and proceeding six days. The Douglas PUD uses these discharge estimates to inform inflow into the Wells Project. When inflow values are expected to exceed turbine discharge, or when the Douglas PUD has reason to believe that spill is likely, Douglas PUD institutes minimum generation requirements on all participants of the Wells Project. Douglas PUD has the ability to both put minimum generation requirements on the Wells Project directly, as well as enforce and control to these requirements. Douglas PUD generates to whatever minimum generation requirements is on the Wells Project without regard to the signals it receives from its participants, should those signals be less than the required minimum project generation. Further, to maintain compliance with TDG standards, the District also sends its Wells Project discharge estimates to the immediately downstream project, Rocky Reach, operated by Chelan County PUD.

4.6 Reporting

Douglas PUD shall provide a draft annual report to the Aquatic SWG summarizing the previous year's water quality activities and activities proposed for the coming year, in accordance with the WQMP and as determined by the Aquatic SWG. The report will include any decisions, statements of agreement, evaluations, or changes made pursuant to this WQMP. If significant activity was not conducted in a given year, Douglas PUD may prepare a memorandum providing an explanation of the circumstances in lieu of the annual report. A summary of monitoring

results, any analyses and compliance with the WQS numeric criteria will be included in an appendix to the annual report.

4.6.1 *Progress Towards Meeting Annual Reporting Requirements*

In addition to the reporting requirements found within the Aquatic Settlement Agreement requiring the submission of annual reports for all six of the management plans including the WQMP, Article 406 of the FERC license for the Wells Project also requires Douglas PUD to submit annual reports detailing the implementation of each of the six Aquatic Settlement Agreement management plans. This report is intended to satisfy those reporting requirements associated with the new license for the Wells Project.

4.6.2 Study Plans

Douglas PUD shall prepare study plan(s) that include QAPP(s) for each parameter to be monitored. The QAPPs shall follow the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (July 2004 Ecology Publication Number 04-03-030) or its successor. The QAPPs shall contain, at a minimum, a list of parameter(s) to be monitored, a map of sampling locations, and descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and equipment, analytical methods, quality control procedures, data handling and data assessment procedures and reporting protocols.

Douglas PUD shall review and update the QAPPs annually based on a yearly review of data and data quality. Ecology may also require future revisions to the QAPP based on monitoring results, regulatory changes, changes in Project operations, and/or the requirements of TMDLs.

The initial QAPPs and any changes shall be submitted to the Aquatic SWG for review and are subject to approval by Ecology. Implementation of the monitoring program shall begin upon Ecology's written approval of the QAPP, unless otherwise provided by Ecology.

4.6.2.1 *Progress Towards Meeting Objective 5 in 2017 - Study Plans*

No new QAPP were developed in 2017, since no new monitoring was conducted. The QAPP developed and approved in 2013 for water temperature and TDG monitoring was used in 2017 as a guiding document to implement water quality moniting in and around the Wells Project area in 2017.

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EXHIBIT A

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2017 WATER TEMPERATURE ANNUAL REPORT

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

February 21, 2018

Prepared by:

Public Utility District No. 1 of Douglas County
East Wenatchee, WA

Prepared for:
Washington Department of Ecology
Yakima, WA

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6.0 INTRODUCTION

The Wells Hydroelectric Project (Wells Project or Project) is owned and operated by the Public Utility District No. 1 of Douglas County (Douglas PUD). On November 9, 2012, Douglas PUD received a new 40-year license for the Wells Project from the Federal Energy Regulatory Commission (FERC). During the FERC licensing process, Douglas PUD submitted to the Washington Department of Ecology (Ecology), an application for a 401 Water Quality Certification (401 Certification) on September 30, 2010, pursuant to the provisions of 33 USC §1341 (§401 of the Clean Water Act [CWA]). On September 12, 2011, Douglas PUD withdrew its request and reapplied. On February 27, 2012, Ecology concluded that the Wells Project, as conditioned by its 401 Certification/Order No. 8981, complied with all applicable provisions of 33 USC 1311, 1312, 1313, 1316, 1317 and appropriate requirements of Washington State law (Ecology 2012).

Pursuant to the Wells Project License Order and the 401 Certification, Douglas PUD is required to maintain compliance with the state Water Quality Standard (WQS) for water temperature through continued implementation of a monitoring program and to prepare an annual report of the monitoring results and analyses for submittal by April 30 of the following year (Ecology 2012).

This annual report summarizes water temperature activities implemented at the Wells Project in 2017. Background activities including the Project description, regulatory framework, past Wells Project temperature activities, and 401 Certification temperature requirements are presented in Section 2.0. Implementation results for 2017 are presented in Section 3.0 and include the implementation of an Ecology-approved Quality Assurance Project Plan (QAPP) for water temperature, and the results of water temperature monitoring activities within the Wells Project.

7.0 BACKGROUND

7.1 Project Description

The Wells Project is located at river mile (RM) 515.6 on the Columbia River in the State of Washington. Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Dam, owned and operated by the U.S. Army Corps of Engineers (USACE), and 42 miles upstream from the Rocky Reach Dam, owned and operated by Public Utility District No. 1 of Chelan County. The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from the Wells Dam.

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774.3 MW and a peaking capacity of approximately 840 MW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of Well Dam, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet in height. The juvenile fish bypass system (JBS) was developed by Douglas PUD and uses a barrier system to modify the intake velocities on all even numbered spillways (2, 4, 6, 8 and 10).

The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5 miles up the Methow River and approximately 15.5 miles up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at elevation of 781 feet above mean sea level (msl). The normal maximum water surface elevation of the reservoir is 781 feet (Figure 1).

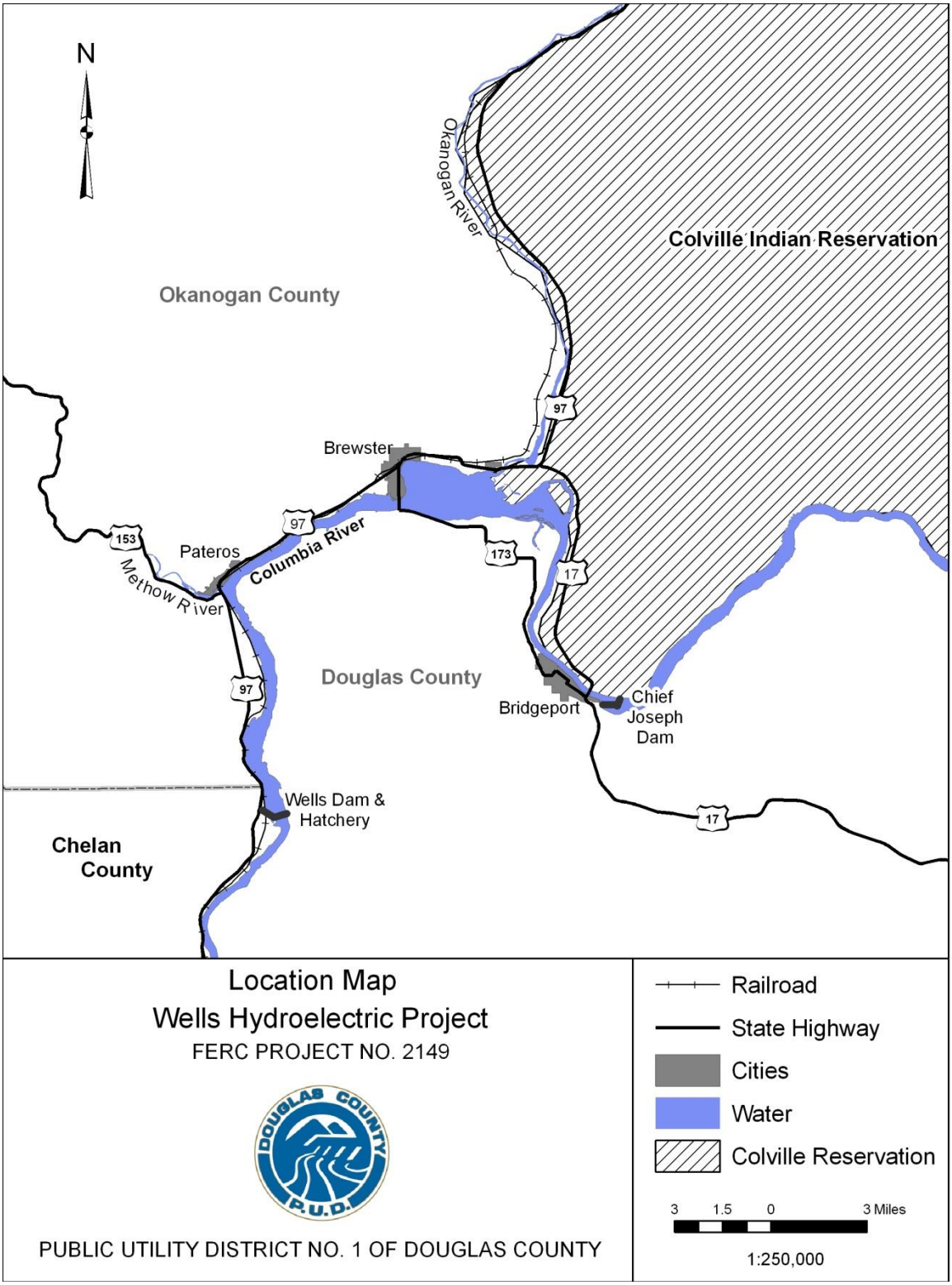

Figure 1. Location Map of the Wells Project.

7.2 Regulatory Framework

7.2.1 Temperature Water Quality Standard

Temperature is measured by the 7-day average of the daily maximum temperatures (7-DADMax). The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date (WAC 173-201A-020).

Under the Washington State WQS, the 7-DADMax temperature within the Columbia, Methow, and Okanogan river portions of the Wells Project shall not exceed 17.5°C (63.5°F) (WAC 173-201A-602 and 173-201A-200(1)(c)). When a water body's temperature is warmer than 17.5°C (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F).

In addition to the numeric criteria above, the WQS contains additional supplemental temperature requirements for the Project portion of the Methow River (i.e., Methow River Supplemental Requirements). Ecology has identified water bodies, or portions thereof, which require special protection for spawning and incubation in accordance with Ecology publication 06-10-038. This publication indicates where and when the following criteria are to be applied to protect the reproduction of native char, salmon, and trout. Water temperatures are not to exceed 13°C from October 1 to June 15 in the lower Methow River including the portion within the Project boundary (up to RM 1.5).

7.2.2 305(b) Report, 303(d) List and Total Maximum Daily Loads

Every two years, the Environmental Protection Agency (EPA), as specified in section 305(b) of the CWA, requires Ecology to compile an assessment of the State's water bodies. Data collected from the water quality assessment are used to develop a 305(b) report. The report evaluates and assigns each water body into five categories based upon the Ecology's evaluation of the water quality parameters collected from within each water body.

(1) Category 1 states that a water body is in compliance with the State WQS for the parameter of interest.
(2) Category 2 states a water body of concern.
(3) Category 3 signifies that insufficient data are available to make an assessment.
(4) Categories 4a-4c indicates an impaired water body that does not require a Total Maximum Daily Load (TMDL) for one of three reasons:

- Category 4a indicates a water body with a finalized TMDL.
- Category 4b indicates a water body with a Pollution Control Program.
- Category 4c indicates a water body impaired by a non-pollutant (e.g., low water flow, stream channelization, and dams).

(5) Category 5 represents all water bodies within the State that are considered impaired and require a Water Quality Implementation Plan (WQIP) (formerly TMDL). The 303(d) list consists of only water bodies with Category 5 listings.

For temperature, the reach of the Columbia River within the Project is on the State's 2015 303(d) list for temperature impairment. The EPA has developed a draft temperature TMDL for the mainstem Columbia River, including that portion of the Columbia River contained within the Project. It is anticipated that the EPA will issue the final temperature TMDL for the Columbia River at some future date. The TMDL will address the water temperature effects of dams and other human actions, including model analyses and load allocations for mainstem hydroelectric projects including Wells Dam.

The EPA approved Ecology's September 2015 submittal of the latest Water Quality Assessment 305(b) report and 303(d) list on July 22, 2016. The 2015 submittal and assessment fulfills Washington State's obligation under the federal CWA §303(d) and §305(b) to identify polluted waters (known as the 303(d) list) as well as report on the status of water quality statewide where data is available.

The reach of the Methow River within the Project (RM 1.5) is not on the 2015 303(d) list for temperature. Slightly upstream of project boundary however, the Methow River is listed as a category 5 and 303(d) listed since samples taken between 7/7/2010 and 9/30/2010, showed that the 7-DADMax exceeded the criterion for this waterbody (17.5°C) on 41 of 86 days (48%).

The reach of the Okanogan River within the Project (RM 15.5) is listed as a 305(b) and category 2 for temperature. The listing is a result of one sample in 2002 that showed excursions of the criteria 17.5°C for this waterbody. However, annual reporting conducted by Douglas PUD and the U.S. Geological Survey (USGS) shows that incoming temperatures at the Project boundary in the Okanogan River routinely exceed the 17.5°C standard in the summer months and therefore is a result of loading that occurs in water prior to entry in the Project area.

7.3 Wells Project Water Temperature Activities

7.3.1 Wells Reservoir and Tributaries

Beginning in 2001, an extensive water temperature monitoring effort was initiated by Douglas PUD in order to better understand the temperature dynamics throughout the Wells Reservoir. Temperature data was collected by Douglas PUD at four locations in the Columbia River (RM 544.5, RM 535.3, RM 530.0, and RM 515.6) and at one site each on the Okanogan (RM 10.5) and Methow (RM 1.4) rivers. Data collected by Douglas PUD were collected hourly using Onset© Tidbit temperature loggers. Monitoring start and end dates varied from year to year but generally began in the early spring and ended in late fall. Quality assurance and control measures were implemented prior to deploying and upon retrieving temperature loggers to ensure that data collected were accurate.

The 7-DADMax temperature data recorded since 2001 indicate that the portion of the Columbia River upstream of and within the Project generally warms to above 17.5^{o}C (WQS numeric criteria) in mid-July and drops below the numeric criterion by early October. Temperatures in

the Methow River upstream of the Project warm to above 17.5°C in mid-July and drop below the numeric criterion by September, while trends in the Okanogan River upstream of the Project indicate warming above 17.5°C starting in early June with cooling below the criteria by late September.

To assess compliance with the state WQS for temperature (during the Wells Project FERC relicensing process), two 2-dimensional laterally-averaged temperature models (using CE-QUAL-W2) were developed that represented existing (or "with Project") conditions and "without Project" conditions of the Wells Project, including the Columbia River from the Chief Joseph Dam tailrace to Wells Dam, the lowest 15.5 miles of the Okanogan River, and the lowest 1.5 miles of the Methow River. The results were processed to develop daily values of the 7-DADMax, and then compared for the two conditions.

The model analyses demonstrated that "with Project" temperatures in the Columbia, Okanogan and Methow rivers do not increase more than 0.3°C compared to ambient ("without Project") conditions anywhere in the reservoir, and that the Project complies with the state WQS for temperature (West Consultants Inc. 2008). However, as identified in the Wells Project 401 Certification, a full evaluation of potential temperature impacts of hydroelectric power generation on the Columbia River will most likely require analysis of hydraulic and temperature conditions on a system-wide basis. Hydraulic and temperature influences from upstream storage dams complicate the evaluation of Project-related impacts. The only way to properly understand these impacts is to examine the river water temperatures more comprehensively through a system-wide TMDL study such as that which is under consideration for development by EPA and the USACE.

Importantly, the Wells Project is a "run-of-river" Project with limited storage capacity. For example, the Grand Coulee Project has more than 50 times the storage when compared to the Wells Project. Wells Reservoir has an operating range of 771-781 feet above sea level, but it is operated within the 779-781 range more than 95% of normal operation. As such, inflows on a given day approximate outflow volumes. Water particle transport time from Chief Joseph Dam to Wells Dam is 39.4-37.0 hours under moderate 111 kcfs flows (GeoEngineers Technical Memo 2009), and therefore water has very limited time to take up thermal load. Taking storage, operations, and particle transport time together, the Wells Project temperature profile mimics the profile of combined inflow temperatures when accounting for input volume (Methow, Okanogan and Columbia River conditions).

7.3.2 Wells Dam Fish Ladders

According to the terms and conditions found in the Biological Opinion (BO) supporting the implementation of the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) all entities that use the fish ladder trapping facilities at Wells Dam are required to monitor the water temperatures within the ladders every two hours from May 1 to November 15 and to discontinue trapping operations when fish ladder water temperatures exceed 69.8ºF (21.0°C). In 2001, Douglas PUD added supplemental temperature recording equipment at Pool 39 near the broodstock collection facilities in the east fishway at Wells Dam to ensure compliance with requirements in the National Marine Fisheries Service (NMFS) HCP BO. In 2001 and 2002, hourly data indicated that water temperatures at this location in the east fish ladder did not

exceed 69.8º F (21.0°C) at any time during the monitoring period, which ran from late July to early December.

7.4 401 Certification Temperature Requirements

The Wells Project 401 Certification requires that Douglas PUD maintain compliance with the state WQS for water temperature (via citation of the Wells Project Water Quality Management Plan [Douglas PUD 2008]) by monitoring water temperature at various Wells Project locations at certain times of the year and transmitting these data on a daily basis to a web-accessible database. Specific 401 Certification requirements include:

1. Prepare a QAPP for each water quality parameter to be monitored. QAPPs shall follow the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (July 2004 Ecology Publication Number 04-03-030).

2. Monitor water temperatures at three boundary locations of the Wells Project (Methow River RM 1.5, Okanogan River RM 10.5, and Columbia River RM 544.5) and in the Well Dam Forebay and Tailrace on an hourly basis, from April 1st to October 31st.

3. Continue to collect hourly fish ladder temperatures 24 hours a day during the upstream fish passage season (currently May 1 to November 15) at the Wells Dam East Fishway Pool No. 39[2].

4. Monitor water temperatures hourly in the auxiliary water supply system and near the east shore of the Wells Dam Forebay (bottom, middle, and surface depths) during the upstream fish passage season (May 1 to November 15).

5. Transmit hourly temperature data on a daily basis to a web-accessible database maintained by Douglas PUD and available to Ecology, regional fish management agencies, and the public.

6. Develop an annual report of the monitoring results and analyses, in a format approved by Ecology, and submit it by April 30 of the following year.

8.0 IMPLEMENTATION RESULTS

8.1 Quality Assurance Project Plan

As required by the 401 Certification section 6.7(7)(a)(i), Douglas PUD developed a Wells Project QAPP for water temperature and total dissolved gas (TDG) (Douglas PUD 2013). The QAPP describes a systematic approach for collecting high quality and reliable data that may be used to determine compliance of these parameters with the State of Washington's WQS for the Wells Project. With regard to temperature, the QAPP contains a map of sampling locations, descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and

[2] Douglas PUD monitor water temperatures in the Wells Dam fishways during trapping periods in order to remain in compliance with hatchery permitting.

equipment, analytical methods, quality control procedures, data handling and data assessment procedures and reporting protocols (Douglas PUD 2013). The QAPP was provided to Ecology for review on March 4, 2013 and subsequently approved. Douglas PUD submitted the QAPP to the FERC on June 21, 2013, which issued an order approving the QAPP on August 8, 2013.

8.2 Temperature Monitoring Equipment

8.2.1 Equipment Acquisition

Prior to the issuance of a new Wells Project FERC License, Douglas PUD collected temperature data using Onset© Tidbit temperature loggers (see Section 2.3.1 above), which were programmed to collect hourly data year-round and required retrieval in order to download and report data. Douglas PUD retrieved and downloaded loggers two to four times a year depending upon river conditions and access.

Per the Wells Project 401 Certification section 6.7(3)(a)(iii), hourly temperature data was required to be transmitted to a web-accessible database maintained by Douglas PUD and available to Ecology, regional fish management agencies, and the public. To meet the daily data transmission requirement, Douglas PUD applied for and received permits, before acquiring and subsequently installing new temperature monitoring equipment. At each temperature monitoring location, equipment consists of a Design Analysis H-377 temperature sensor, Sutron GOES radio/logger, GOES satellite antenna and cable, 20 watt solar panel, and voltage regulator. On shore housing includes a National Electrical Manufacturers Association enclosure, 12 volt sealed lead-acid battery, galvanized pipe, flex conduit, fittings, and other hardware (Figure 2). The system consists of a sensor connected to a communications box with wireless modem access. Data is collected hourly and sent wirelessly and uploaded to Douglas PUD's publicly available webpage in real time. The system is powered by battery and charged using a solar panel (Douglas PUD 2013).

Figure 2. **Remote water temperature station that sends data in real time using GOES satellite link.**

8.2.2 Equipment Installation

Consistent with 401 Certification section 6.7(3)(a)(i-iii), remote water temperature sensors were installed at eight locations in the Wells Project during 2013 and have been collecting seasonal data since then. Locations and required durations of monitoring include:

April 1st to October 31st:

1. Methow River, RM 1.5 - Project Boundary
2. Columbia River, RM 544.5 - Chief Joseph Dam Tailrace
3. Okanogan River, RM 10.5 - Project Boundary
4. Wells Dam Forebay (data from TDG sensor)
5. Wells Dam Tailrace (data from TDG sensor)

May 1st to November 15th:

6. Wells Dam East Fishway, Pool No. 39
7. Wells Dam Auxiliary Water Supply
8. Wells Dam Forebay (three depths)

Temperature monitoring locations are illustrated in Figures 3 through 6.

Figure 3. **Temperature monitoring at and around Wells Dam (graduated green circles are intended to show surface middle and deep depths).**

Figure 4. **Methow River temperature monitoring location (RM 1.5). The location of the sensor is approximated by the green circle.**

Figure 5. **Okanogan River temperature monitoring location (RM 10.5). The location of the sensor is approximated by the green circle.**

Figure 6. **Chief Joseph Tailrace (Columbia River RM 544.5) temperature monitoring. The location of the sensor is approximated by the green circle.**

In May of 2013, Douglas PUD entered into a Joint Funding Agreement with the USGS to install and maintain remote water temperature equipment at four of the eight monitoring locations including the Wells Dam Forebay (three depths), the Methow River, the Okanogan River, and the Chief Joseph Dam Tailrace. The Wells Dam Forebay and Tailrace sensors are maintained by Columbia Basin Environmental (these sensors collect both temperature and TDG data year round) but data is managed by Douglas PUD. The remaining two locations (Wells Dam East Fishway and Wells Dam Auxiliary Water Supply) were installed and are maintained by Douglas PUD.

Following approval of the QAPP, securing required permits, and equipment acquisition, the USGS began installation of temperature sensors at four locations. The Chief Joseph Dam Tailrace and Okanogan River sensors were installed in July 2013 and the Methow River and Wells Forebay locations were completed in October 2013. The Wells Dam Forebay and Tailrace sensors began collecting data on April 1, 2013 after being calibrated and installed by Columbia Basin Environmental. Douglas PUD installed sensors at two locations; the Wells Dam East Fishway and Auxiliary Water Supply, these stations were upgraded and installed respectively during the month of October 2013.

In October 2013 Douglas PUD launched a new website where hourly temperature data is transmitted daily and is publicly accessible. This webpage provides a link to all real-time temperature data at http://www.dcpud.org/wells-project/total-dissolved-gas-and-temperature-monitoring. In addition, historic water temperature data and 2016 data featured in this report is available from this website.

8.3 Temperature Data Results

Temperature data from new equipment was available towards the end of the compliance year 2013. As such, water temperature monitoring using Tidbit sensors from Onset© was discontinued by the end of 2013. The 2017 annual report consists exclusively of data from the new wireless transmitting temperature equipment. In general, observed 2017 water temperatures in tributaries that feed into the Wells Project were cooler on average earlier in the year compared to historic observations, which was attributed to a cool wet spring compared to average. Generally, peak summer water temperatures were consistent with the ten year water temperature profile (2008-2017).

In all subsequent figures, horizontal lines at 17.5 or 13°C illustrate 7-DADMax thresholds, aside from Figure 14 where the 21^{o}C trapping threshold is denoted (see section 3.4.8).

8.3.1 Chief Joseph Dam Tailrace

The Chief Joseph Dam Tailrace temperature sensor location is at RM 544.5 on the left bank (looking downstream) of the Columbia River near the town of Bridgeport, WA. Water temperature data is collected from April 1 to October 31 and is indicative of incoming water temperature conditions to the Wells Project at this location.

Water temperature ranged from 5.1 to 19.7°C during the monitoring period. 7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from July 28 - October 08, 2017 (Figure 7; Table 1).

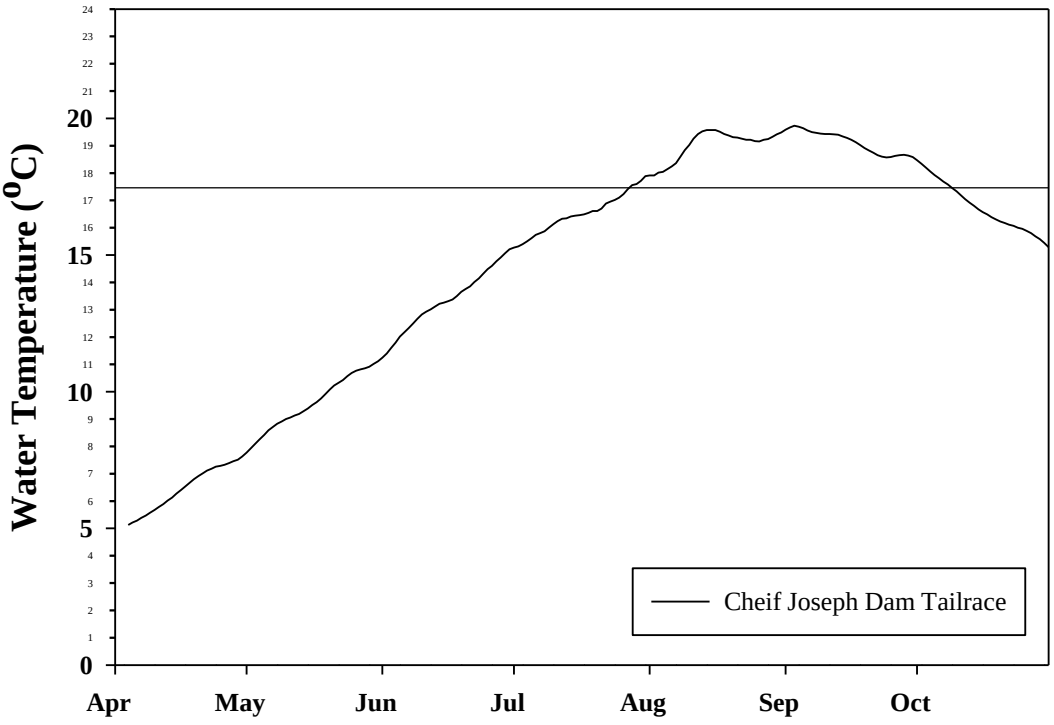

Figure 7. Water temperature data collected in the Chief Joseph Tailrace.

8.3.2 Okanogan River Boundary

The Okanogan River Boundary monitoring location is at RM 10.5. This station is located upstream of the influence of the Wells Project and as such is representative of natural temperature conditions for the Okanogan River. Per requirements, water temperature is gathered at this location from April 1 to October 31 of each year and is generally indicative of incoming water temperature conditions to the Wells Project at this location. The USGS maintains operations of this sensor. 7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from June 21, 2017 to Sept 16, 2017 (Figure 8).

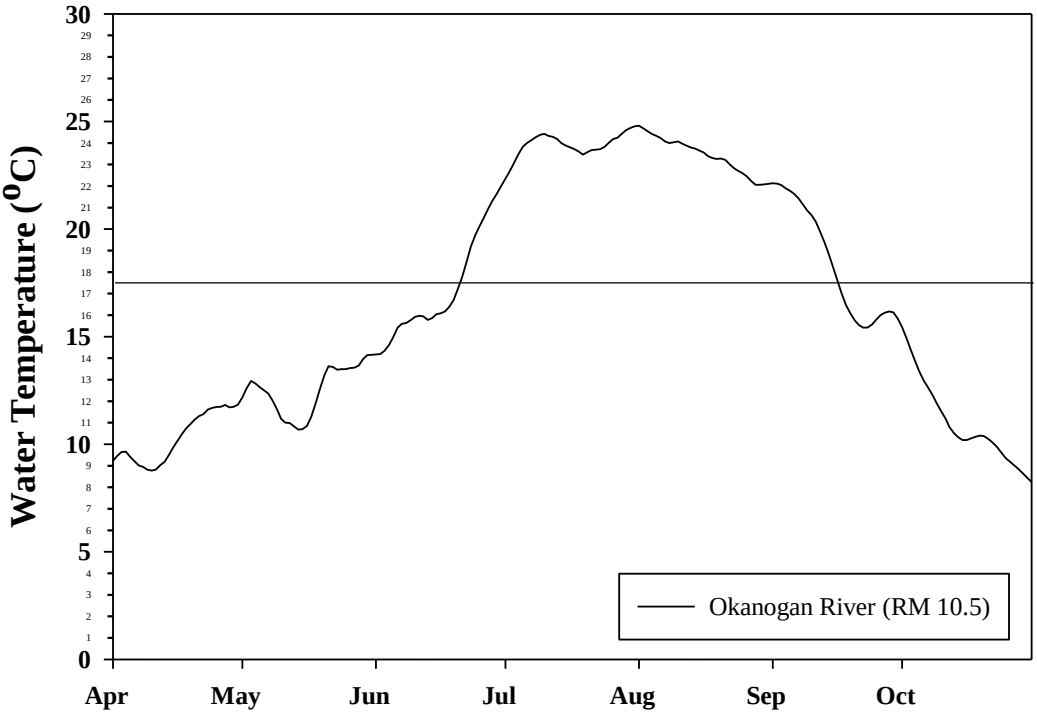

Figure 8. Water temperature data collected in the Okanogan River at RM 10.5.

8.3.3 Methow River Boundary

The Methow River Boundary monitoring location is at RM 1.5 on the left bank near Pateros, WA. This station is located upstream of Project influence and, as such, is representative of natural temperature conditions for the Methow River. Water temperature data is required to be collected from April 1 to October 31 and is indicative of incoming water temperature conditions to the Wells Project at this location. In addition to the WQS numeric criteria of 17.5°C, Ecology has identified this portion of the Methow River as requiring special protection for spawning and incubation in accordance with Ecology publication 06-10-038. This publication indicates where and when the following criteria are to be applied to protect the reproduction of native char, salmon, and trout. In the lower Methow River water temperatures are not to exceed 13°C from October 1 to June 15. During 2017, the natural flowing Methow River had daily average water

temperatures that were at or above 13°C from June 21, 2017 to October 2, 2017. 7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from July 6, 2017 to September 13, 2017 (Figure 9).

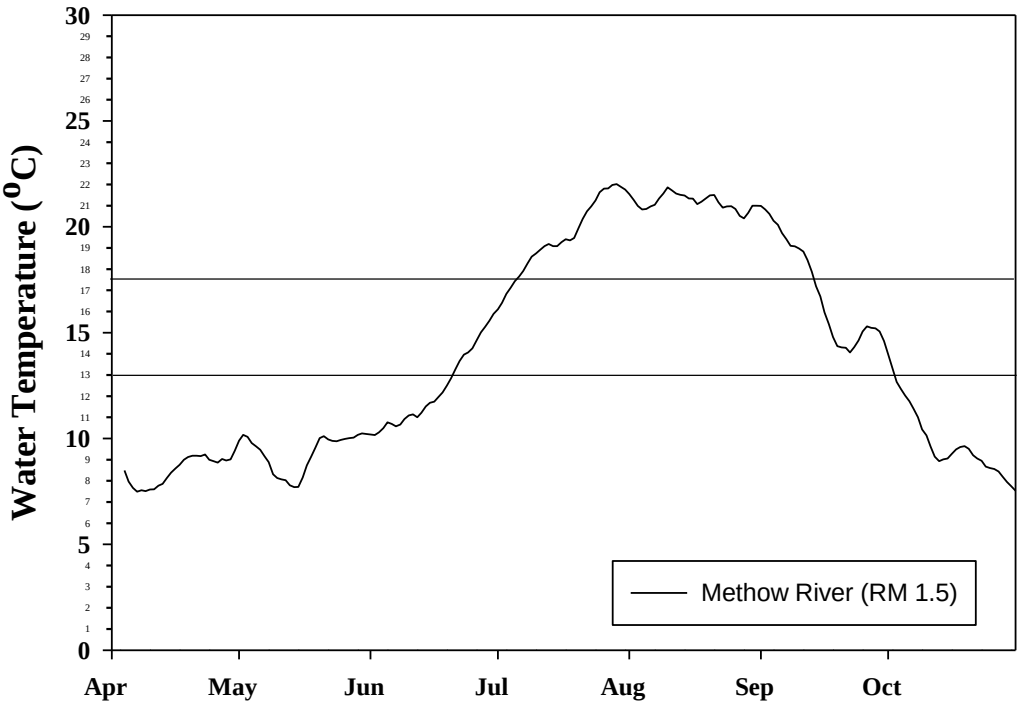

Figure 9. **Water temperature data from the Methow River at RM 1.5. Criterion of 13°C applies only from October 1- June 15 each year (bottom horizontal line).**

8.3.4 Wells Dam Forebay

The Wells Dam Forebay location, where temperatures are required to be collected hourly from April 1 to October 31 of each year, is located on the face of pier nose 6 at Wells Dam. Columbia Basin Environmental maintains operations of this sensor (collects both temperature and TDG) and Douglas PUD manages the data. 7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from July 23, 2017 to October 6, 2017 (Figure 10; Table 1), which is generally consistent with historic Wells Project temperature monitoring data (see section 2.3.1).

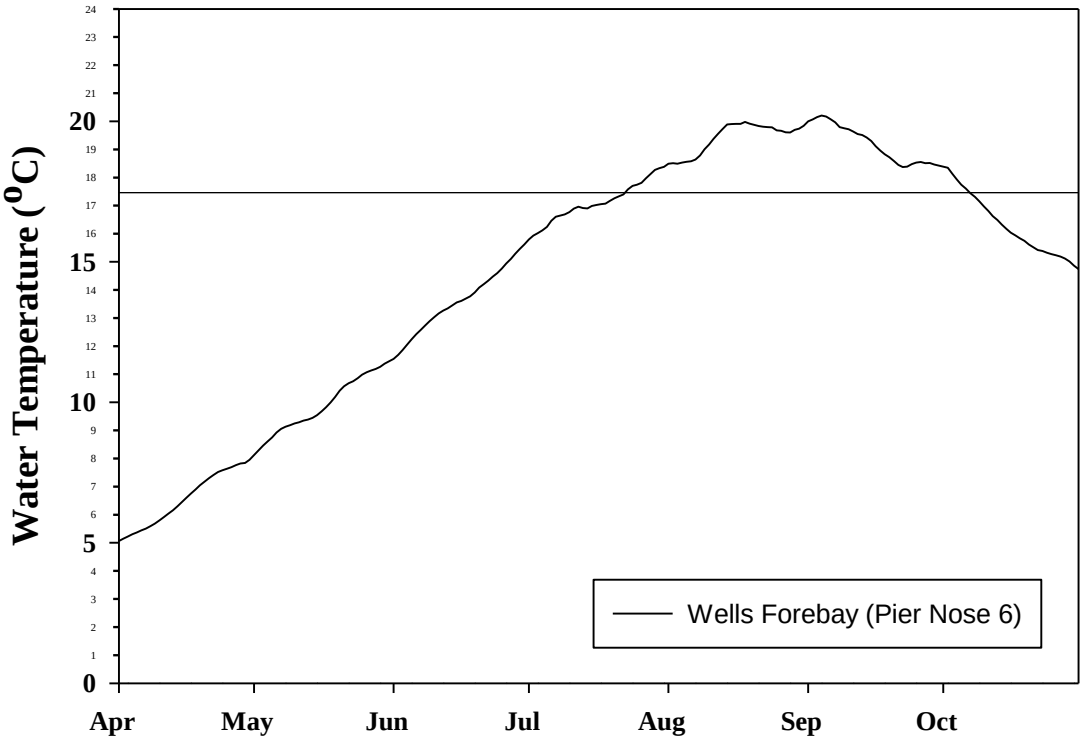

Figure 10. Water temperature data collected in the Wells Dam Forebay at pier nose 6.

8.3.5 Wells Dam Tailrace

The Wells Dam Tailrace location, where temperatures are required to be collected hourly from April 1 to October 31 of each year, is located approximately 2 miles downstream of Wells Dam on the left bank of the river. Columbia Basin Environmental maintains operations of this sensor (collects both temperature and TDG) and Douglas PUD manages the data. 7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from August 7, 2017 to October 6, 2017 (Figure 11; Table 1), which is generally consistent with historic Wells Project temperature monitoring data (see section 2.3.1). A lightning strike in late June caused catastrophic damage to call components of this site. Wells Dam technicians attempted to replace components of the site over the course of several weeks during the month of July 2017. 7-DADMax values were not computed until the beginning of August as a result of this station failure (See Figure 11). We suspect 7-DADMax values were above 17.5°C on July 23, 2017 since the forebay sensor is usually consistent with the tailrace site.

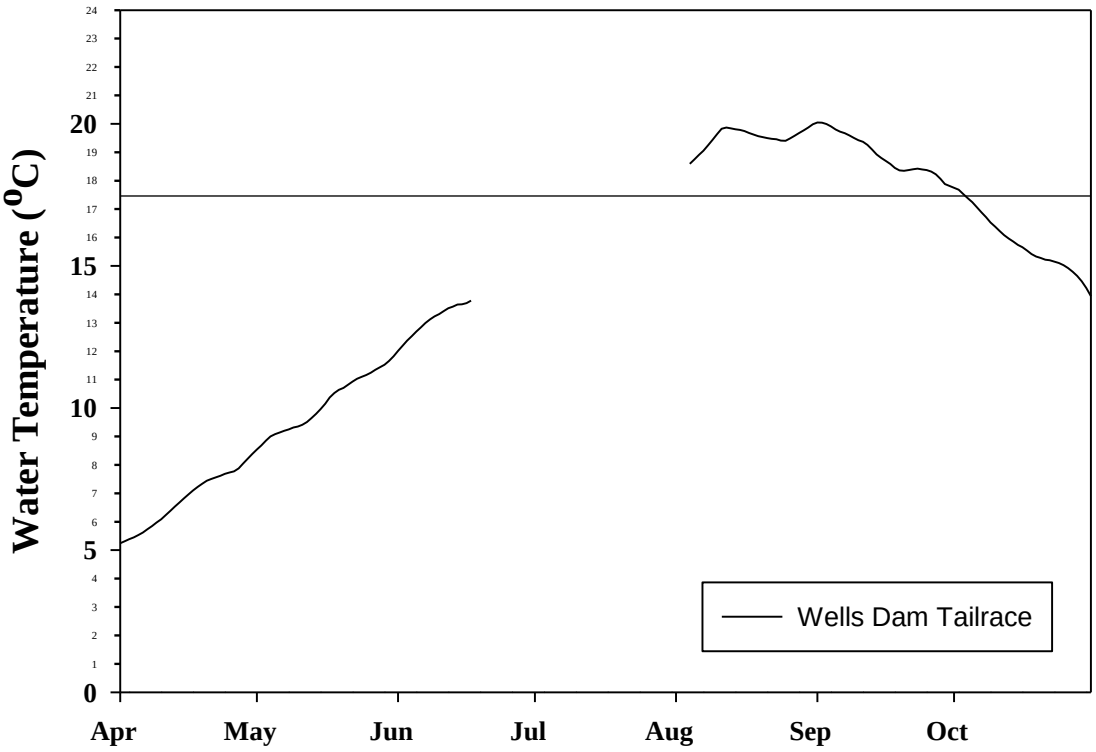

Figure 11. Water temperature data collected in the Wells Dam Tailrace.

8.3.6 Wells Dam Forebay Multiple Depth Requirement

The Wells Dam Forebay temperature monitoring location is at RM 515.8. Monitoring at this location is required between May 1 and November 15. Temperature data is collected at three depths to provide temperature profiles throughout the water column at this location. Sensors are located near the surface (<2m depth), mid-water column (approximately 10m), and near bottom (>30m). Data obtained from 2013-2017 show that thermal stratification does not occur at this location (Figure 12A; e.g. 2016 observations) despite small differences in 7-DADMax observations. 2017 data showed a maximum difference of 1.3 ^{0}C on July 9, 2018, but water temperature differences between the bottom and the upper and middle sensors persisted for much of the monitoring period. Specifically, a difference of 0.5-1.3 ^{0}C (Figure 12B) seemed to persit from late spring to December 1st when USGS technicians checked the sensor and realized the bottom sensor needed a 0.5 ^{0}C correction[3]. Nevertheless data from the bottom sensor was not adjusted prior to December 1 2017. Given the observation of the 0.5 ^{0}C drift on Decemeber 1 2018 and four years of data between 2013-2017 we suspect the diffence between the bottom sensor and the surface sensor was a instrumentation error rather than a real difference. The lack of thermo-stratification in the Wells Forebay was confirmed during relicensing efforts conducted

[3] *Personal communication*; Nathan Esh, nesh@usgs.gov email 2/12/2018.

by Douglas PUD and West Consultants (West Consultants Inc., 2008). Given the run-of-river nature of the Well Project, retention time is insufficient for thermo-stratification to occur.

7-DADMax temperature values at this location were above the WQS numeric criteria (17.5°C) from July 23, 2017 to October 6, 2017 at both the surface and middle sensor and from August 8, 2017 to October 1, 2017 for the bottom sensor (Table 1). However, we are suspicious that the bottom sensor had an instrumentation issue during the monitoring period.

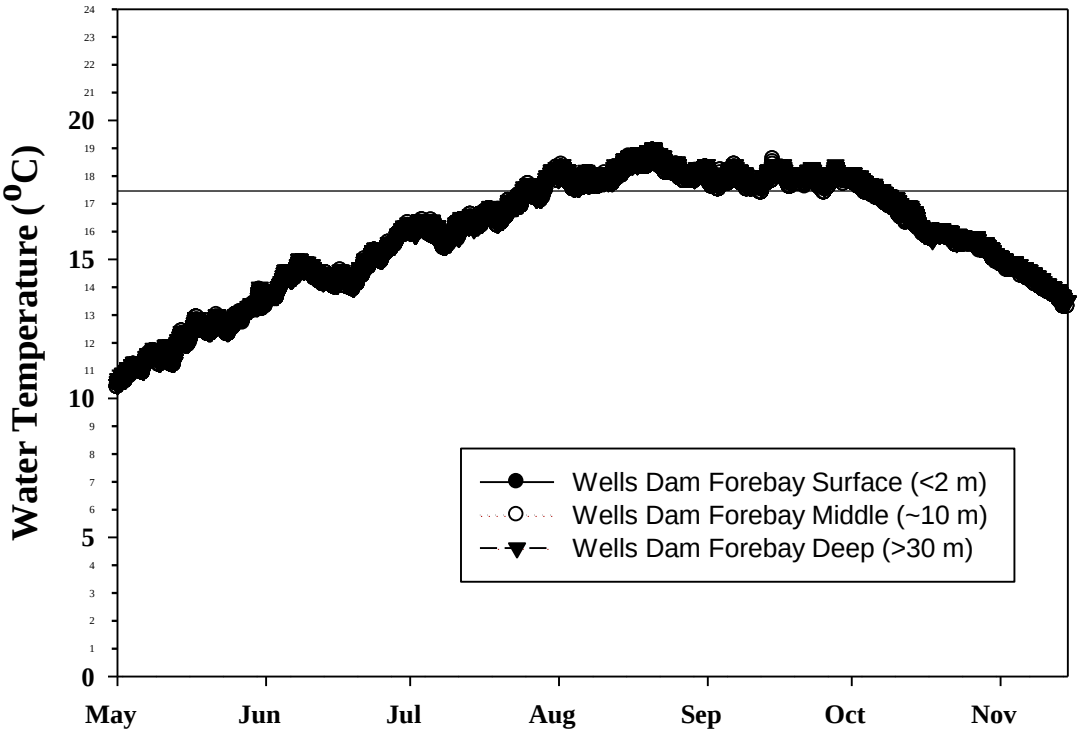

Figure 12A. Water temperature data collected in the Wells Dam Forebay at three depths in 2016. Temperature profiles show the lack of stratification in this location during the time period.

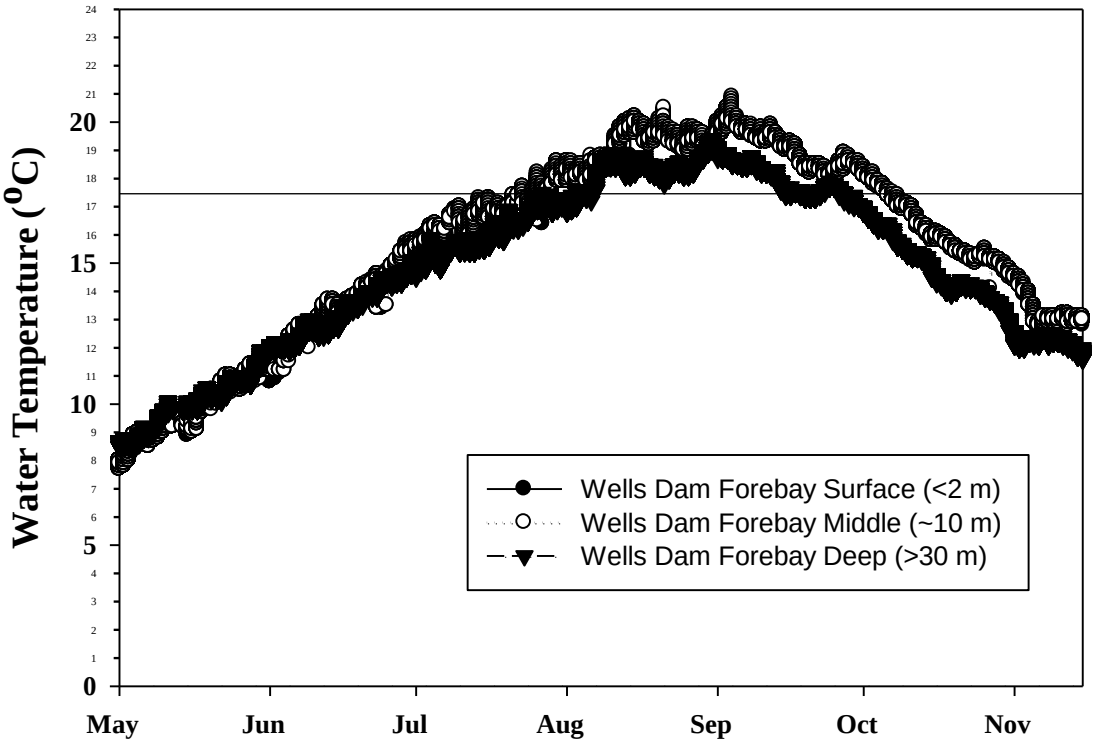

Figure 12B. Water temperature data collected in the Wells Dam Forebay at three depths during 2017. Temperature profiles appear to show sensor drift beginning in June and perisisting past November 15. USGS technicians adjusted the lower sensor during a December 1st site visist by 0.5 ^{0}C (data not shown).

8.3.7 Wells Dam Auxiliary Water Supply

The Wells Dam Auxiliary Water Supply location is within the lower west fishway adjacent to the collection gallery. Water from this location originates from the tailrace and is used to provide additional water for the lower 22 pools of the fishway including the fish collection gallery (Douglas PUD 2001). Monitoring at this location is required between May 1 and November 15. Results indicate that temperatures were above the 7-DADMax (17.5^{o}C) from July 25, 2017 to October 8, 2017 (Figure 13; Table 1).

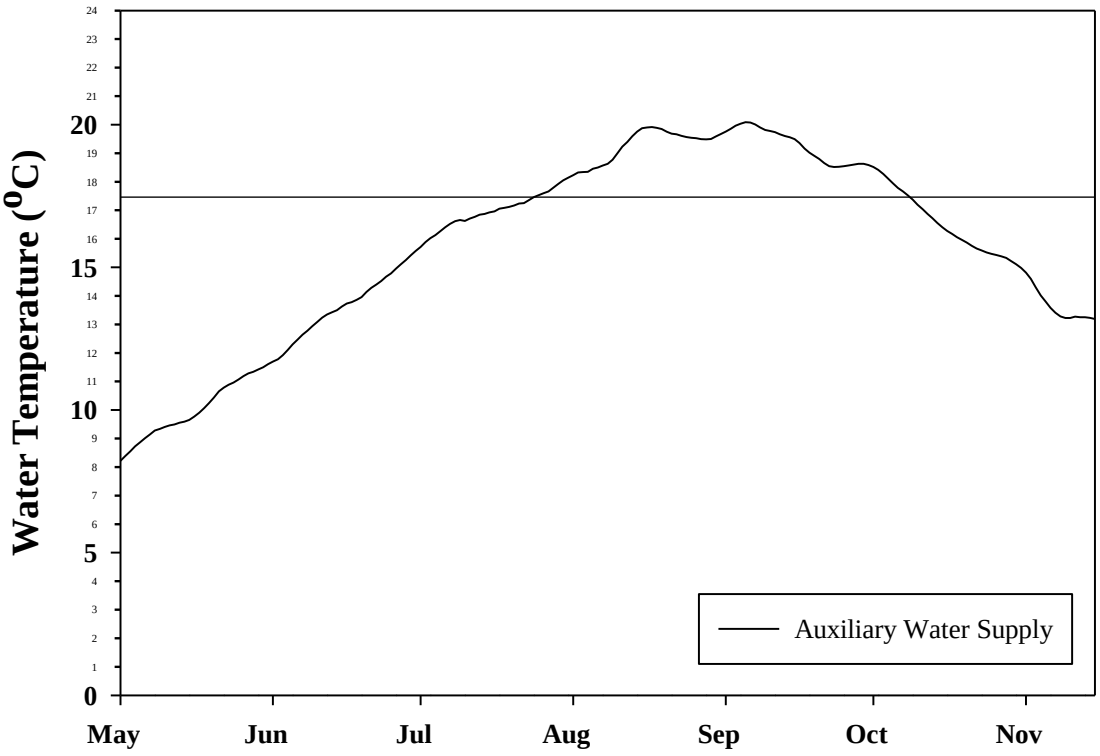

Figure 13. Water temperature data collected in the auxiliary water supply system at Wells Dam.

8.3.8 Wells Dam East Fishway Pool No. 39

According to the HCP hatchery permits, all entities that use the fish trapping facilities at Wells Dam are required to monitor the ladders every two hours May 1 to November 15 and discontinue trapping operations when fish ladder water temperatures exceed 69.8ºF (21.0°C). The Wells Project 401 Certification also adopted this requirement with the addition of hourly monitoring. Wells fish ladders did not reach this threshold in 2017 with the highest water temperature being recorded as 20.09°C on September 4, 2017. In addition, results indicate that temperatures were above the 7-DADMax (17.5°C) from July 26, 2017 to October 6, 2017 (Figure 14; Table 1).

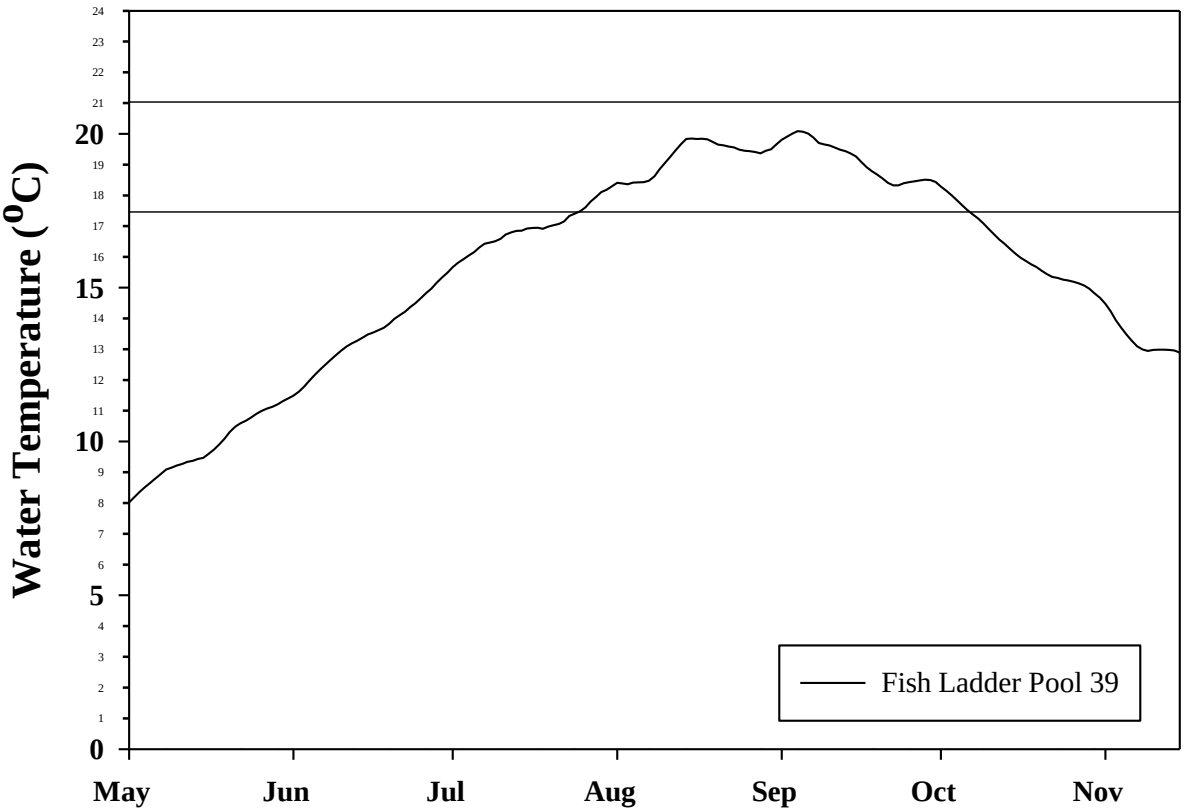

Figure 14. **Water temperature data collected in Pool 39 of the east fish ladder at Wells Dam. The horizontal line at 21°C (top line) denotes the threshold whereby adult broodstock trapping at Wells Dam discontinues and the horizontal line at 17.5 (bottom line) denotes the 17.5°C 7-DADMax.**

Water temperature data from the 2017 monitoring season for all locations and sources are summarized in Table 1 and indicate that during the summer water temperatures (i.e., 7-DADMax values) at multiple locations within the Wells Project were above the state WQS of 17.5°C. However, as discussed in more detail in the conclusions, the thermal regime observed was consistent with the temperatures recorded at Chief Joseph Dam, and Methow and Okanogan rivers. The temperatures observed during 2017 were also consistent with historical temperature data collected and evaluated using the CE-QUAL-W2 model which found that the Wells Project remains in compliance with the state WQS.

Table 1. **7-DADMax by location as determined by remote real time temperature sensor.**

Location	*Number of Required Monitoring Days*	*Actual Number of Days Monitoring*	*Number of days exceeding 7-DADMax*	*Days exceeding 7-DADMax (17.5°C)*
Chief Joseph Tailrace	4/1 – 10/31 (n = 214)	214	73	7/28 – 10/08
Okanogan RM 10.5	4/1 – 10/31 (n = 214)	214	88	6/21 – 9/16
Methow RM 1.5	4/1 – 10/31 (n = 214)	214	70	7/6 – 9/13
Wells Forebay Pier Nose 6	4/1 – 10/31 (n = 214)	214	74	7/23 – 10/6
Wells Tailrace	4/1 – 10/31 (n = 214)	214	59*	8/7* – 10/6
Wells Forebay Surface	5/1 – 11/15 (n = 199)	199	76	7/23 – 10/06
Wells Forebay Mid	5/1 – 11/15 (n = 199)	199	76	7/23 – 10/06
Wells Forebay Deep	5/1 – 11/15 (n = 199)	199	55**	8/08 – 10/01**
Auxiliary Water Supply	5/1 – 11/15 (n = 199)	199	76	7/25 – 10/08
Pool 39 East Fish Ladder	5/1 – 11/15 (n = 199)	199	73	7/26 – 10/06

*7-DADMax values were likely above criteria on 7/23 for 74 days but a lightning strike destroyed the site in June 2017.

** Observations and correction applied on December 1, 2017 by USGS technicians leads us to suspect that actual days of exceeding 7-DADMax was likely closer to 76 like that which was observed at the surface and middle sensor.

9.0 CONCLUSIONS

During the 2017 monitoring period, all stations recorded data in accordance with Douglas PUD's Wells Project 401 Certification requirements. Data was made available in real time at www.dcpud.org. Data collection in 2017 was exceptionally complete with only significant data loss during the month of July in the Wells Dam Tailrace. Data loss was associated with a lightning strike that damaged the tailrace station. In August 2017 the site returned to service. Data recorded at the face of the dam, inside the fish ladder at pool 19 and in the auxiliary water supply suggest that outgoing water temperatures at Wells Dam were consistent with incoming water temperatures when the tailrace station was not operational.

In general, data indicates that the thermal regime observed during the Wells Project relicensing process is still reflective of current observations. In 2017 temperatures warmed to above the WQS criteria of 17.5°C consistent with recent averages and cooled in a likewise fashion. In addition, exceedances of the WQS appear to be associated with water entering the Wells Project that was out of compliance due to the operation of large storage projects upstream of Wells Dam and inflows from the Okanogan and Methow Basin as observed in 2017. There were 73 days when water entering the Wells Project via Chief Joseph Dam discharges was above the 7-

DADMax and 73 days above the same criteria in the Wells fish ladders that was shifted only by two days, which supports the fact that the Project did not have an additive temperature effect. Data collected in 2017 confirms that spring temperatures and local basin snowpack drive the rate at which water temperatures increase at Project boundary locations similarly to late summer rain and flow regimes above Wells Dam. Monitoring will continue, consistent with 401 Certification requirements during the 2018 monitoring period.

10.0 REFERENCES

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