

From: [Clement, Marcie](#)
To: ["Breean Zimmerman"](#)
Cc: [Osborn, Jeff](#); [Sokolowski, Rosana](#); [Bitterman, Deborah](#); [Clement, Marcie](#)
Subject: DRAFT 2018 Gas Abatement Plans for Rocky Reach and Rock Island
Date: Wednesday, February 28, 2018 8:34:52 AM
Attachments: [DRAFT-2018-Rock-Island-GAP_2018-02-12.docx](#)
[DRAFT-2018-Rocky-Reach-GAP_2018-02-12.docx](#)

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

To: Breean Zimmerman, Washington State Department of Ecology

From: Marcie Clement, Program Manager – Water Resources
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: DRAFT 2018 Total Dissolved Gas Abatement Plans for the Rocky Reach and Rock Island projects

Ms. Zimmerman:

Attached for your review, comment and final approval are the DRAFT 2018 Total Dissolved Gas Abatement Plans and links to the appendices for the Rocky Reach and Rock Island projects. Please review and submit any comments you may have on or before 5:00 p.m. March 28, 2018 via email at marcie.clement@chelanpud.org.

Links to appendices

HCPs

http://www.chelanpud.org/docs/default-source/default-document-library/rr_hcp.pdf

http://www.chelanpud.org/docs/default-source/default-document-library/ri_hcp.pdf

2010 QAPP

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

2017 Total Dissolved Gas Annual Report

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/52589.pdf

If you have any questions, please do not hesitate to contact me.

Thank you,

Marcie Clement | Program Manager – Water Resources

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

2018 TOTAL DISSOLVED GAS ABATEMENT PLAN

DRAFT

**ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943**

February 28, 2018



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

TERMS AND ABBREVIATIONS

7Q10	seven-day, ten-year frequency flood stage
12C-High	12 highest consecutive hourly readings
BPA	Bonneville Power Administration
CCT	Confederated Tribes of the Colville Reservation
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Anadromous Fish Agreement and Habitat Conservation Plan
kcf	thousand cubic feet per second
MW	megawatt
NMFS	National Marine Fisheries Service
NNI	No Net Impact
NOAA	National Oceanic and Atmospheric Administration
Project	Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RIFB	Rock Island Forebay
RITR	Rock Island Tailrace
RRFB	Rocky Reach Forebay
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

WAC	Washington Administrative Code
WANF	Wanapum Forebay
WDFW	Washington Department of Fish and Wildlife
WQC	401 Water Quality Certification
WQS	Washington State Water Quality Standards

TABLE OF CONTENTS

Executive Summary	vii
1.0 Introduction.....	1
1.1 Project Description.....	1
1.2 River Flows	3
1.3 Regulatory Framework.....	4
1.3.1 Total Dissolved Gas Standards	4
1.3.2 Fish Spill Season.....	5
1.3.3 Incoming Total Dissolved Gas Levels	5
1.3.4 Flood Flows – 7Q10.....	5
1.3.5 Total Dissolved Gas Total Maximum Daily Load.....	5
1.4 Project Operations	5
1.4.1 Habitat Conservation Plan	6
1.4.2 Other International and Regional Agreements	6
1.4.3 Spill Operations	7
1.5 Spill and Total Dissolved Gas Compliance – Previous Year 2017	9
1.5.1 Spill.....	9
1.5.2 Total Dissolved Gas Compliance 2017.....	10
1.5.3 TDG Activities Implemented in 2017.....	12
1.5.4 TDG Structural Measures Implemented in 2017	12
2.0 Proposed 2018 Action Plan to Achieve TDG Standards	13
2.1 Operational TDG Abatement Measures	13
2.2 Proposed Structural TDG Abatement Measures and Technologies.....	13
3.0 Physical and Biological Monitoring and Quality Assurance	14
3.1 Fixed-Site Monitoring Station for TDG.....	14
3.2 Quality Assurance	17
3.3 Biological (Gas Bubble Trauma) Monitoring Plan	17
4.0 TDG Compliance Reporting Methods	18
4.1 Water Quality Website	18
4.2 Notifications	18
4.3 Annual Report	18
5.0 Updates to the Gas Abatement Plan.....	19
6.0 Conclusions.....	20
7.0 List of Literature	21

LIST OF APPENDICES

- Appendix A: Rock Island Habitat Conservation Plan
- Appendix B: 2018 Rock Island TDG Operational Plan
- Appendix C: 2010 Quality Assurance Project Plan
- Appendix D: 2017 Total Dissolved Gas Annual Report
- Appendix E: Response to Comments

LIST OF FIGURES

- Figure 1-1. Location of Rock Island Project on the Columbia River 2
- Figure 1-2. Comparison of 2017 vs. previous 10-year average (2007-2016) of mean daily discharge at Rock Island Dam 4
- Figure 3-1. Location of forebay FMS at Rock Island Project 15
- Figure 3-2. Location of tailrace FMS below Rock Island Project 16

LIST OF TABLES

- Table 1-1. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2017 9
- Table 1-2. Summary of hourly averages TDG measurements from each FMS during the 2017 fish spill season 11

EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) as required by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish¹ passage past hydroelectric dams when consistent with an Ecology-approved GAP. Public Utility District No.1 of Chelan County (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Rocky Island Hydroelectric Project (Project) during 2018 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rock Island Habitat Conservation Plan and Anadromous Fish Agreement (HCP). This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP [Appendix A]), TDG Operational Plan (Appendix B), a Quality Assurance Project Plan (QAPP [Appendix C]) for Rocky Reach Water Quality Monitoring and Reporting, and the 2017 Total Dissolved Gas Annual Report (Appendix D).

WAC water quality standard 173-201A-200(1)(f)(ii) provides a temporary criteria adjustment for hydroelectric dams on the Snake and Columbia Rivers, when spilling to aid in fish passage. To receive this criteria adjustment, an Ecology-approved GAP is required. In the 401 Water Quality Certification for the Rocky Reach Project (WQC), the non-fish spill season is defined as September 1 through March 31 and the fish spill season as April 1 through August 31. Chelan PUD assumes the same timeframes for the Rock Island Project.

The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage and an Ecology-approved GAP is in place:

- TDG must not exceed an average of 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 percent as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings [12C-High] in any one day, relative to atmospheric pressure).
- A maximum TDG 1-hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the Rock Island GAP is to implement measures to achieve compliance with the Washington State water quality standards (WQS) for TDG in the Columbia River at the Project while continuing to meet the fish passage and survival standards set forth in the HCP and Anadromous Fish Agreement (Appendix A).

¹ Unless otherwise noted “fish” refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the Rocky Reach WQC. These measures include, but are not limited to the following:

1. Minimizing voluntary spill.
2. Managing voluntary spill levels during downstream migrating juvenile fish passage in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

Additionally, Chelan PUD proposes to implement the following measures:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations (FMS). TDG data will be collected on an hourly basis throughout the year and will be reported to U.S. Army Corps of Engineers Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's fish spill season flow, TDG, gas bubble trauma (GBT) monitoring, and fish (could include juvenile and adult) study results, and, in accordance with the previous (2018) GAP, submit to Ecology by December 31.

1.0 Introduction

Public Utility District No. 1 of Chelan County (Chelan PUD) owns and operates the Rock Island Hydroelectric Project (Project), located on the Columbia River approximately 12 miles downstream of the city of Wenatchee (Figure 1-1). The Project is licensed as Project No. 943 by the Federal Energy Regulatory Commission (FERC).

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) according to Washington Administrative Code (WAC) 173-201A-200(1)(f)(ii). Chelan PUD respectfully submits this GAP with the goal of receiving a total dissolved gas (TDG) criteria adjustment for commencing with the 2018 fish spill season. This GAP provides details associated with proposed 2018 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

A 401 Water Quality Certification (WQC) for the operation of Chelan PUD's Rocky Reach Project was issued by Ecology on March 17, 2006 (Ecology 2006). The 2018 Rock Island TDG monitoring and reporting will be conducted in a manner consistent with the TDG and gas abatement monitoring and reporting requirements within the Rocky Reach WQC.

1.1 Project Description

Rock Island Project is owned and operated by Chelan PUD. The structure is 3,800 feet in length and is constructed from reinforced concrete. The dam is located at Columbia River mile 453.4, about 12 miles downstream from the city of Wenatchee. The Project contains a reservoir extending 21 miles upriver to the tailrace of Rocky Reach Dam and covers 3,300 acres. The Project has no significant water storage capabilities. The normal maximum reservoir elevation of the Rock Island Project is 613 feet with a tailrace elevation of 572 feet and a head of 41 feet. The Project discharges into a reservoir ponded by Wanapum Dam located 37.6 miles downstream.

The Rock Island Project consists of two powerhouses. Powerhouse 1 is located on the east bank of the Project at a 45-degree angle from the bank. The powerhouse consists of 10 vertical shaft turbines with a rated output of 212 megawatts (MW). Powerhouse 2 is located on the west bank and is 470 feet wide, housing eight horizontal shaft turbines with a rated power output of 410 MW. The combined hydraulic capacity of both powerhouses is 220 thousand cubic feet per second (kcfs).

The Project configuration includes a spillway of 32 bays with a total length of 1,184 feet. Gates are separated by a middle adult fish ladder (located at bay 15) that divides the spillway into east and west sections. The west (Chelan County side) spillway consists of seven deep bays and 10 shallow bays, and the east (Douglas County side) spillway consists of six deep bays and eight shallow bays. Each spillway has two or three crest gates, which are stacked one on top of the other. The crest gates are 30 feet wide and either 11 or 22 feet high. The larger crest gates are positioned closest to the water surface, and when fully raised, spill approximately 10 kcfs.

The deep bays have a sill elevation of 559 feet, which is about 13 feet below the average tailwater elevation of 572 feet. The shallow bays have a sill elevation of 581.5 feet, which is about 9.5 feet above the average tailwater elevation.

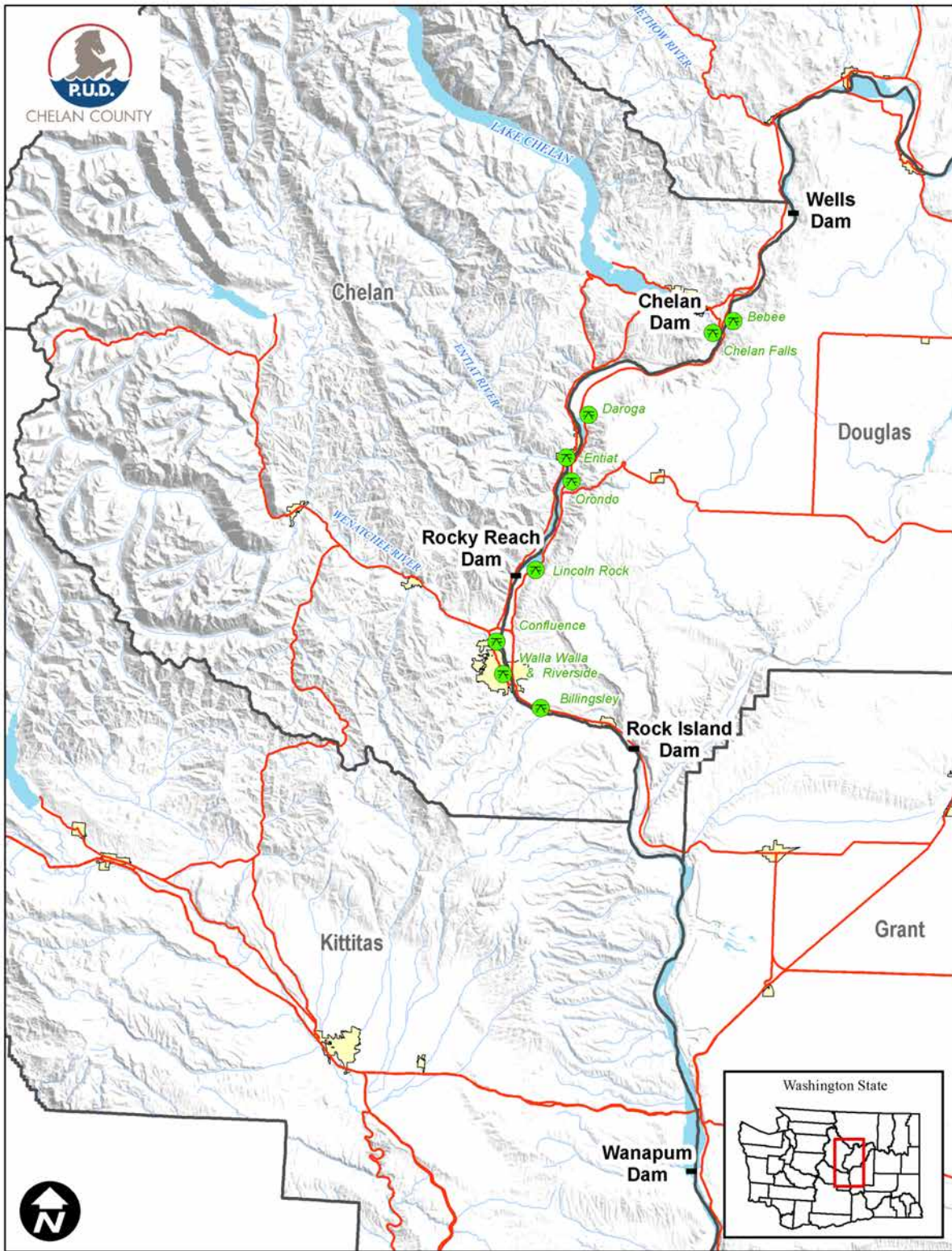


Figure 1-1. Location of Rock Island Project on the Columbia River

The focus of juvenile fish bypass at Rock Island Dam has been directed towards optimizing the efficiency of fish passage via spill. To achieve this, nine of the 32 spill bays have had their spill gates modified to provide surface spill. Surface spill was accomplished by putting notches in the upper sections of six spill gates. The notches are 8 feet wide by 17 feet deep and can spill up to 2,500 cubic feet per second (cfs). The total amount of water that can be passed through the notched gates is approximately 13,000 cfs. The remaining three modified gates have an “over-under” design that enables surface flow attraction and releases water through a 6-inch gap at the bottom of the downstream gate slot (below the surface of the tailwater), thus reducing the uptake of atmospheric gases. The total amount of water that can be passed through the “over-under” gates is approximately 7,200 cfs (2,400 cfs per gate). The total amount of spill flow for notched and “over-under” gates combined is approximately 21,000 cfs.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington, and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2017 flows at the Rock Island Project is shown in Figure 1-2.

Mean daily discharge during the 2017 fish spill season was compared to the 10-year average of mean daily discharge from 2007-2016, as measured at Rock Island Dam. Over the entire fish spill season, mean daily flow discharges during 2017 were greater than the 2007-2016 average (about 116.8% of average at Rock Island Dam). The average flows for April, May, and June were greater than the 10-year average and the average flows for July and August were lower than the 10-year average. The maximum daily average observed at Rock Island Dam was 265.2 kcfs on June 9, 2017. Of the 153 days during the spill season (April 1 through August 31), there was 1 day when the daily average flow exceeded the seven-day, ten-year frequency flood stage (7Q10) value (264 kcfs) at Rock Island Dam.

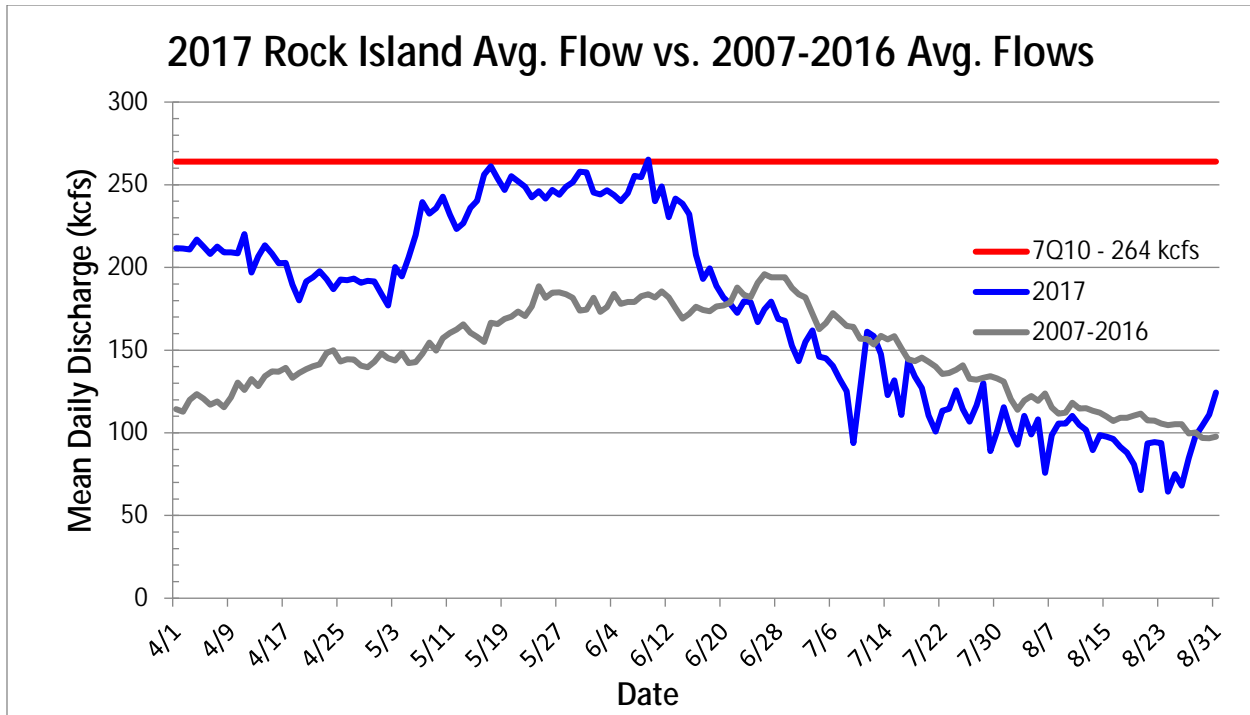


Figure 1-2. Comparison of 2017 vs. previous 10-year average (2007-2016) of mean daily discharge at Rock Island Dam

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

WAC 173-201A-200(1)(f) address standards for the surface waters of Washington State. Under the water quality standards (WQS), TDG shall not exceed 110 percent at any point of measurement in any state water body; however, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when an Ecology-approved GAP is in place. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, a temporary criteria adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG criteria adjustment. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any 1-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive hourly readings (12C-High) in any one day (24-hour period). 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 fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

1.3.2 Fish Spill Season

Section 5.4.2 of the Rocky Reach WQC defines the fish spill season (for downstream migrating juveniles) as April 1 through August 31 of each year. The non-fish spill season is defined as September 1 through March 31. Chelan PUD has assumed these dates also apply to Rock Island Dam.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rock Island Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows – 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the 7Q10. The 7Q10 flood flow for the Rock Island Project was calculated to be 264 kcfs (Pickett et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River, which set TDG allocations for each dam (Pickett et al., 2004). With the option for a temporary TDG criteria adjustment under an Ecology-approved GAP, the TMDL set TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations (FMS). Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

1.4 Project Operations

The Rock Island Project operates within the constraints of its FERC regulatory and license requirements, as well as other plans and agreements. Chelan PUD plans to implement the following operational measures at Rock Island Dam:

1. Minimize voluntary spill – due to the success thus far of the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) survival studies, Chelan PUD has been able to reduce spring fish (voluntary) spill from 20 percent to 10 percent of the daily average river flow
2. Manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria during fish passage, using the TDG Operational Plan
3. Minimize spill, to the extent practicable, by scheduling maintenance based on predicted flows
4. Minimize spill past unloaded turbines, to the extent practicable, by continuing to impose minimum generation limits on the hydroelectric projects.

1.4.1 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Project on salmon and steelhead.

The HCP serves as the foundation for the fisheries management plan at Rock Island Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the species named within the HCP, to the “maximum extent practicable” as required by the Endangered Species Act (ESA). HCP species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and Coho salmon. The HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including, but limited to, spill and powerhouse operations. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at the Rock Island Project under 10 percent spill operations.

1.4.2 Other International and Regional Agreements

The Columbia River is managed, and the Rock Island Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- **Columbia River Treaty:** An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.
- **Pacific Northwest Coordination Agreement:** An agreement among the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.
- **The Federal Columbia River Power System (FCRPS) Biological Opinion:** By NMFS, applies to actions by the USACE, the USBR, and BPA for impacts on ESA-listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.
- **Hanford Reach Fall Chinook Protection Program Agreement:** The three mid-Columbia PUDs, National Oceanic and Atmospheric Administration (NOAA) Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CCT), and BPA have agreed to river flow management actions to support Public Utility District No. 2 of Grant County’s (Grant PUD’s) effort to manage the flow in the Hanford Reach to protect fall

Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.3 Spill Operations

It is recognized that achieving regulatory TDG levels may not be possible during spill associated with large flood (7Q10) events; however, at Rock Island Dam it may be possible to achieve current regulatory TDG levels during releases for fish bypass and up to the 7Q10 flows (264 kcfs) by selective operation of spillway bays. The Rock Island Project is unique due to the diversity of variations in how flow is released, which may assist in the development of spill scenarios that could result in a reduction of gas in the tailrace.

There are seven main scenarios that may result in spill at Rock Island Dam. These are, but are not limited to the following:

1. Fish Spill

As part of the HCP, Chelan PUD is required to meet survival standards for fish migrating through the Projects. Juvenile dam passage survival is a key component of Project survival. At Rock Island Dam, spill is still the preferred method of moving fish past the Project, with most of the spill being passed through the modified “notched” spill gates. Results of survival studies conducted at Rock Island Dam have enabled Chelan PUD to reduce voluntary (fish) spill in the spring from 20 percent of the daily average flow to 10 percent of the daily average flow. Summer spill at Rock Island Dam remains at 20 percent of the daily average flow. This summer spill level was set by the HCP in 2002 and will remain at 20 percent until such time Chelan PUD is able to test survival of subyearling (summer) Chinook. To date, Chelan PUD has not been able to test survival due to tag technology limitations and uncertainties regarding the life history (migration behavior) of subyearling Chinook. The 20 percent spill level must be maintained until tag technology becomes available that will enable us to accurately measure survival at the current spill level.

Spring Fish Spill Operations

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island Dam under 10 percent spill operations. Chelan PUD will continue spilling 10 percent through the spring migration. Spring fish spill will begin no later than April 17 and will continue until the end of the spring outmigration (95 percent passage point), and subyearling Chinook have arrived at the Project.

Summer Fish Spill Operations

Summer spill at Rock Island Dam for subyearling Chinook will be 20 percent of day average flow over 95 percent of the summer outmigration. Summer spill will commence after the completion of spring spill. Summer spill for subyearling Chinook generally ends no later than August 15 when 95 percent of the migration of subyearling Chinook has passed the Project. Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time. Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

2. Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license, to prevent overtopping of the Project, and to maintain optimum operational conditions. With this type of release, flows up to, and in excess of the 7Q10 flood flows (264 kcfs) can be accommodated. To reduce negative impacts of flow in excess of hydraulic capacity, Chelan PUD completed and implemented a TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

3. Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

4. Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

5. Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. FERC requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

6. Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

7. Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the-river projects such as Rock Island Dam.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance – Previous Year 2017

1.5.1 Spill

At Rock Island Dam, there was involuntary (forced) spill April 1 through May 25 with the placement of the over/under gates in preparation for the start of the spring fish spill season. Between April 16 and May 25, 9.69 percent of the total volume was voluntary, while 25.53 percent was involuntary (forced) spill. Between May 26 and August 18 (summer fish spill period), spill was both voluntary and involuntary. From August 22 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates. Information regarding spill for the 2017 fish spill season are displayed in Table 1-1 and Appendix D.

Table 1-1. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2017

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish Spill			Other		
			Spill kcfs	Percent of Flow	Percent of Total Spill	Spill kcfs	Percent of Flow	Percent of Total Spill
April	203.3	62.5	9.7	4.8	15.5	52.9	26.0	84.5
May	236.8	96.8	39.7	16.8	41.0	57.1	24.1	59.0
June	212.9	74.8	46.8	22.0	62.5	28.0	13.2	37.5
July	127.3	24.9	24.7	19.4	99.5	0.1	0.1	0.5
August	94.7	12.6	11.7	12.4	93.4	0.8	0.9	6.6

1.5.2 Total Dissolved Gas Compliance 2017

Over the course of the 2017 fish spill season, there were 4 exceedances of the TDG numeric criteria in the Rock Island Forebay (RIFB) and 73 exceedances in the Rock Island Tailrace (RITR). There were 17 exceedances at the Wanapum Forebay (WANF). There were 0, 879, and 77 hourly exceedances of the 125 percent numeric criteria in the RIFB, RITR, and WANF, respectively.

Table 1-2 displays the total number of times TDG levels exceeded the current WQS during the 2017 fish spill season as measured at each of Chelan PUD's FMS applicable to the Rock Island Project as well as the WANF FMS (owned/operated by Grant PUD). The total number of exceedances also reflects the omission of exceedances caused by the previous day's hourly values, if those same hourly values also created a 12-hour average TDG value above standards for the previous day.

Table 1-2. Summary of hourly averages TDG measurements from each FMS during the 2017 fish spill season

Location ¹	Number of 115/120 Percent Exceedances					Number of 125 Percent Exceedances		
	Spring Spill	Summer Spill	Total	Total # of Days ²	Percent Below Standard	Total Hours	Total # of Hours ²	Percent Below Standard
RIFB	4 ³	0 ⁴	4	153	97.4	3,668	0	100.0
RITR	48 ⁵	25 ⁶	73	153	52.3	3,665	879 ⁹	76.0
WANF	5 ⁷	12 ⁸	17	153	88.9	3,672	77	97.9
Total	57	37	91	459	80.2	11,005	956	91.3

Notes:

¹ RRFB = Rocky Reach Forebay, RIFB = Rock Island Forebay, RITR = Rock Island Tailrace, WANF = Wanapum Forebay.

² Based on total number of available days/hours minus days/hours omitted due to TDG membrane failures or other QA/QC issues.

³ 49 days of the 55 days of RIFB Spring Spill had 12C-High TDG values greater than 115 percent; however, 45 days were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RRFB and/or 12C-High flows were exceeded 7Q10 at Rock Island Dam.

⁴ 30 days of the 98 days of RIFB Summer Spill 12C-High TDG values exceeded the 115 percent standard; however, all 30 days of RIFB 12C-High TDG values were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RRFB and/or 12C-High flows were exceeded 7Q10 at Rock Island Dam.

⁵ 51 days of the 55 days of RITR Spring Spill 12C-High TDG values exceeded the 120 percent standard; however, the daily 12C-High flows exceeded 7Q10 for 3 days.

⁶ 28 days of the 98 days of RITR Summer Spill 12C-High TDG values exceeded the 120 percent standard; however, the daily 12C-High flows exceeded 7Q10 for 3 days.

⁷ 53 days of the 55 days of WANF Spring Spill had 12C-High TDG values greater than 115 percent; however, 48 days were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RIFB.

⁸ 41 days of the 98 days of WANF Summer Spill 12C-High TDG values exceeded the 115 percent standard; however, 29 days were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RIFB.

⁹ A total of 1,066 RITR hours exceeded the 125 percent standard; however, 187 of those 1,066 hourly exceedances occurred when the daily 12C-High and hourly flows exceeded 7Q10 at Rock Island Dam.

1.5.3 TDG Activities Implemented in 2017

In 2017, Chelan PUD implemented four actions to minimize voluntary and involuntary spill at Rock Island to meet TDG water quality standards. The primary operational action to reduce spill at the Rock Island Project was the implementation of the operational spill programs and the ability to minimize spill through success of survival studies. These efforts included the following:

- Minimizing voluntary spill
- Managing voluntary spill levels during fish passage in real time to meet TDG numeric criteria
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows
- Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

1.5.4 TDG Structural Measures Implemented in 2017

No structural gas abatement measures were proposed or constructed in 2017; however, Chelan PUD continues to utilize the over/under gates that were installed in 2007 to reduce TDG generation at the Project.

2.0 Proposed 2018 Action Plan to Achieve TDG Standards

The following sections describe TDG abatement measures proposed for implementation during 2018 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Chelan PUD will manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and associated Anadromous Fish Agreement. During the 2018 fish spill season, Chelan PUD proposes to use a combination of the following measures, as needed, to meet water quality criteria for TDG:

1. Minimize voluntary spill

Success of the survival studies have allowed Chelan PUD to reduce spring spill required for fish passage

2. Manage voluntary spill in real time

During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria

3. Minimize involuntary spill

Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows

4. Maximize powerhouse discharge as appropriate up to hydraulic capacity.

Operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rock Island Project in 2018. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

3.0 Physical and Biological Monitoring and Quality Assurance

3.1 Fixed-Site Monitoring Station for TDG

Chelan PUD currently maintains two FMSs at the Rock Island Project to monitor hourly TDG levels annually. The FMSs are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rock Island Forebay FMS (Figure 3-1) is affixed to the Project, located on the west side of the river, near the right bank fishway and Powerhouse 2, approximately 70 feet from the shore. The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and Project operations. The site was chosen based on accessibility and is thought to be representative of forebay TDG because water is as well-mixed and flow is as constant as at any other location in the forebay. No bridge or other permanent in-water structure is available downriver of the Rock Island Project on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the Project on the eastern shoreline (Figure 3-2). This FMS has two means of deploying the dissolved gas probe, a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold that holds the carriage system.

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental to perform calibrations and equipment maintenance during the 2018 monitoring season. Calibration and equipment maintenance will be conducted monthly throughout the entire year. Quality assurance/quality control (QA/QC) measures will be accomplished through training in instrument maintenance, operation, and factory-prescribed calibration methods. A detailed log will be maintained for all work done on the monitoring equipment, including monthly maintenance, calibration, exchange of instruments, and any other pertinent information. Redundant measurements with a mobile instrument to verify the accuracy of the in-situ instruments will be conducted during the calibrations.

TDG levels are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on the website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page².

² The website for the USACE, Columbia River Basin Water Management Division, Rock Island Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg. Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.



Figure 3-1. Location of forebay FMS at Rock Island Project



Figure 3-2. Location of tailrace FMS below Rock Island Project

3.2 Quality Assurance

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the U.S. Geological Survey (USGS), USACE, and other mid-Columbia River Dam operators, as well as HydroLab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's Quality Assurance Project Plan (Appendix C) per Section 5.7(2) of the Rocky Reach WQC. These QA/QC protocols are followed at the Rock Island Project.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct gas bubble trauma (GBT) monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead, and subyearling Chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC 2014). The results of this monitoring effort will be included in a TDG annual report (see Section 4.3 Annual Report).

4.0 TDG Compliance Reporting Methods

4.1 Water Quality Website

The Rocky Reach WQC states that TDG information will be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The Rock Island data is posted at this website as well. The data can be found on the website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page³.

4.2 Notifications

Chelan PUD shall notify Ecology, the Central Regional Office, and the Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.3.2 Fish Spill Season, and any deviation from the TDG Operational Plan (Appendix B) or the fish spill plan that adversely affects TDG levels. This notification may be made either electronically or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft TDG annual report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Report will include the following:

- Flow over the preceding year (cfs over time)
- Spill over the preceding year (cfs and duration)
- Reasons for spill (e.g., for fish, turbine down time)
- TDG levels during spill (hourly, to include fish spill season)
- Summary of exceedances and what was done to correct the exceedances
- Results of the fish passage efficiency studies and survival per the HCP
- Result of biological monitoring (GBT) at Rock Island Bypass Trap (conducted in conjunction with the FPC)
- Results of QA/QC implementation.

³ The website for the USACE, Columbia River Basin Water Management Division, Rock Island Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg. Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.

5.0 Updates to the Gas Abatement Plan

Consistent with WAC 173-201A-200(1)(f)(ii), the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

6.0 Conclusions

Chelan PUD shall implement the measures presented Section 2 of this 2018 GAP. Implementation of these measures are intended to ensure compliance with the WAC for TDG in the Columbia River at the Rock Island Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the HCP. No structural gas abatement measures are planned at the Rock Island Project in 2018. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

7.0 List of Literature

- Fish Passage Center (FPC). 2014. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.
- National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.
- Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.
- Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCK ISLAND HABITAT CONSERVATION PLAN

APPENDIX B: 2018 ROCK ISLAND TDG OPERATIONAL PLAN

2018 Rock Island TDG Operational Plan

During Fish Spill Season (April 1 through August 31)

(All spills between these dates are subject to the actions contained in this plan.)

Protocol

1. If tailrace TDG average is greater than **120% for the 6-hour average**
 - monitor for 2 hours, re-check 6-hour average.
 - if TDG >120% for 6-hour average, shift spill from gate 20 to 27
 - monitor for 2 hours, re-check 6-hour average
 - if TDG >120% for 6-hour average, open gate 20 and close 2 notched gates (closure order is listed below)
 - monitor for 2 hours; re-check 6-hour average
 - if TDG >120% for 6-hour average, close two more notched gates
 - **if after closing gates to control TDG levels, the TDG 1-hour average drops below 118%, reopen notched gates in the reverse order of closure.**

Order of notched gate closure: **29, 24, 18, 16.**

2. If tailrace TDG is greater than **125% for 1 hour**
 - follow protocol outlined above, but instead, use **one-hour TDG levels of 125%** as the metric
 - continue until TDG is less than 125% for 1 hour and until the 6-hour average TDG <120%
3. If forebay TDG exceeds 115% for greater than one hour, call Rocky Reach and advise that the RI forebay is out of compliance. Rocky Reach will then reduce spill, but only if the RR forebay TDG is 115% or less. Once RI forebay TDG levels reduce to 113% call RR again so that they may return to previous spill operations.
4. If it becomes necessary to implement any further actions to attain TDG compliance, **please contact Thad Mosey (661-4451, cell 670-5594) and Marcie Clement (661-4186, cell (509) 280-1955) immediately** so they can determine the next steps.

**** Note:** It will not be necessary to monitor for one full hour after re-opening if it appears that TDG is approaching the upper threshold, rather, the procedure will repeat upon reaching the threshold. It is anticipated that in time, the operators will “get a feel” for how much change in TDG will occur as a result of opening or closing gates and it will be possible to hold the TDG around 118% or 119% or so. Once the operators have this down, instead of closing a gate entirely, it may only be necessary to close partially and vice versa for the opening process.

APPENDIX C: 2010 QUALITY ASSURANCE PROJECT PLAN

APPENDIX D: 2017 TOTAL DISSOLVED GAS ANNUAL REPORT

APPENDIX E: RESPONSE TO COMMENTS

2018 TOTAL DISSOLVED GAS ABATEMENT PLAN

DRAFT

**ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145**

February 28, 2018



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

TERMS AND ABBREVIATIONS

7Q10	seven-day, ten-year frequency flood stage
12C-High	12 highest consecutive hourly readings
BPA	Bonneville Power Administration
CCT	Confederated Tribes of the Colville Reservation
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Anadromous Fish Agreement and Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
JBS	Juvenile Fish Bypass System
kcfs	thousand cubic feet per second
License	New FERC License
NMFS	National Marine Fisheries Service
NNI	No Net Impact
NOAA	National Oceanic and Atmospheric Administration
Project	Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RIFB	Rock Island Forebay
RRFF	Rocky Reach Fish Forum
RRTR	Rocky Reach Tailrace
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation

USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQC	401 Water Quality Certification
WQMP	Water Quality Management Plan
WQS	Washington State Water Quality Standards

TABLE OF CONTENTS

Executive Summary	vii
1.0 Introduction.....	1
1.1 Project Description.....	1
1.2 River Flows	4
1.3 Regulatory Framework.....	5
1.3.1 Total Dissolved Gas Standards	5
1.3.2 Fish Spill Season.....	5
1.3.3 Incoming Total Dissolved Gas Levels	5
1.3.4 Flood Flows – 7Q10.....	5
1.3.5 Total Dissolved Gas Total Maximum Daily Load.....	5
1.4 Project Operations	6
1.4.1 2018 Rocky Reach Operations Plan	6
1.4.2 Habitat Conservation Plan	7
1.4.3 Other International and Regional Agreements	7
1.4.4 Spill Operations	8
1.4.4.1 Spill Gate Configuration.....	8
1.4.4.2 Spill Scenarios	9
1.5 Spill and Total Dissolved Gas Compliance – Previous Year 2017.....	11
1.5.1 Spill.....	11
1.5.2 Total Dissolved Gas Compliance 2017.....	11
1.5.3 TDG Activities Implemented in 2017.....	12
1.5.4 TDG Structural Measures Implemented in 2017	13
2.0 Proposed 2018 Action Plan to Achieve TDG Standards	14
2.1 Operational TDG Abatement Measures	14
2.2 Proposed Structural TDG Abatement Measures and Technologies.....	14
3.0 Physical and Biological Monitoring and Quality Assurance.....	16
3.1 Fixed-Site Monitoring Station for TDG.....	16
3.2 Quality Assurance	18
3.3 Biological (Gas Bubble Trauma) Monitoring Plan	18
4.0 TDG Compliance Reporting Methods	19
4.1 Water Quality Website.....	19
4.2 Notifications	19
4.3 Annual Report	19

4.4	Determination of Compliance in Year 5	20
5.0	Updates to the Gas Abatement Plan.....	21
6.0	Conclusions.....	22
7.0	List of Literature	23

LIST OF APPENDICES

Appendix A: Rocky Reach Habitat Conservation Plan
Appendix B: 2018 Rocky Reach TDG Operational Plan
Appendix C: 2018 Operations Plan
Appendix D: 2010 Quality Assurance Project Plan
Appendix E: 2017 Total Dissolved Gas Annual Report
Appendix F: Response to Comments

LIST OF FIGURES

Figure 1-1.	Location of Rocky Reach Project on the Columbia River.....	3
Figure 1-2.	Comparison of 2017 vs. previous 10-year average (2007-2016) of mean daily discharge at Rocky Reach Dam	4
Figure 3-1.	Location of forebay and tailrace FMSs at Rocky Reach Dam.....	17

LIST OF TABLES

Table 1-1.	Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2017.....	11
Table 1-2.	Summary of hourly averages total dissolved gas measurements from each FMS during the 2017 fish spill season.....	12

EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) as required by the 401 Water Quality Certification (WQC) for the Rocky Reach Hydroelectric Project (Project) and by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish¹ passage past hydroelectric dams when consistent with an Ecology-approved GAP. Public Utility District No. 1 of Chelan County (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Rocky Reach Project during 2018 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rocky Reach Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP [Appendix A]), TDG Operational Plan (Appendix B), Rocky Reach Operations Plan (Appendix C), a Quality Assurance Project Plan (QAPP [Appendix D]) for Rocky Reach Water Quality Monitoring and Reporting, and the 2017 Total Dissolved Gas Annual Report (Appendix E).

WAC water quality standard 173-201A-200(1)(f)(ii) provides a temporary criteria adjustment for hydroelectric dams on the Snake and Columbia Rivers, when spilling to aid in fish passage. To receive this criteria adjustment, an Ecology-approved GAP is required. Section 5.4(2) in the Rocky Reach WQC defines the non-fish spill season as September 1 through March 31 and the fish spill season as April 1 through August 31.

The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage and an Ecology-approved GAP is in place:

- TDG must not exceed an average of 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 percent as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings [12C-High] in any one day, relative to atmospheric pressure).
- A maximum TDG 1-hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the Rocky Reach GAP is to implement measures to achieve compliance with the Washington State water quality standards (WQS) for TDG in the Columbia River at the Rocky Reach Project while continuing to meet the fish passage and survival standards set forth in the HCP and Anadromous Fish Agreement (Appendix A).

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the Rocky Reach WQC. These measures include, but are not limited to the following:

1. Minimizing voluntary spill.

¹ Unless otherwise noted “fish” refers to downstream migrating juveniles.

2. Managing voluntary spill levels during downstream migrating juvenile fish passage in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Maximizing powerhouse discharge as appropriate up to 212 thousand cubic feet per second (kcfs).
5. Implementing alternative spillway operations, using gates 2 through 12, to determine whether TDG levels can be reduced without adverse effects on fish passage. If effective, implement to reduce TDG.

Additionally, Chelan PUD proposes to implement the following measures:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations (FMS). TDG data will be collected on an hourly basis throughout the year and will be reported to U.S. Army Corps of Engineers (USACE) Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's fish spill season flow, TDG, gas bubble trauma (GBT) monitoring, and fish (could include juvenile and adult) study results, and, in accordance with the previous (2018) GAP, submit to Ecology by December 31.
4. Prepare an annual water quality report summarizing Chelan PUD's water quality monitoring (to include non-fish spill season TDG data); submit to Ecology by March 1st.

1.0 Introduction

Public Utility District No. 1 of Chelan County (Chelan PUD) owns and operates the Rocky Reach Hydroelectric Project (Project), located on the Columbia River downstream of Wells Dam (Figure 1-1). The Rocky Reach Project is licensed as Project No. 2145 by the Federal Energy Regulatory Commission (FERC). The 401 Water Quality Certification (WQC) for the Rocky Reach Project was issued by the Washington State Department of Ecology (Ecology) on March 17, 2006 (Ecology 2006). The Rocky Reach WQC terms and conditions are incorporated in the new FERC license (License) to operate the Rocky Reach Project which was issued on February 19, 2009 (FERC 2009). Section 5.4.3 of the Rocky Reach WQC requires Chelan PUD to submit an annual Total Dissolved Gas Abatement Plan (GAP) in accordance with Ecology's water quality standards (WQS) for total dissolved gas (TDG) beginning on April 1 of the year of implementation.

This GAP is being submitted to Ecology according to Washington Administrative Code (WAC) 173-201A-200(1)(f)(ii) and Section 5.4.3 of the Rocky Reach WQC. Chelan PUD respectfully submits this GAP with the goal of receiving a TDG criteria adjustment for commencing with the 2018 fish spill season. This GAP provides details associated with proposed 2018 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

1.1 Project Description

The Rocky Reach Project is owned and operated by Chelan PUD. Chelan PUD received a new License from the FERC on February 19, 2009, authorizing Chelan PUD to operate the Project dam and powerhouse for a period of 43 years (FERC 2009).

The Rocky Reach Project consists of a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The dam consists of

- a forebay wall, which is integral to the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment
- a powerhouse approximately 1,088 feet long, 206 feet wide, and 218 feet high that includes 11 generating units and a service bay
- a spillway that is integral to the dam and consists of 12 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate
- two non-overflow east abutment blocks that are integral to the dam, each 125 feet high by 60 feet wide
- an east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet, and
- Dryden weir and Tumwater dam fish ladders and trapping facilities. (These facilities are located some distance away from the Rocky Reach Project on the Wenatchee River).

The Rocky Reach Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. One entrance is located between spillway bays 8 and 9, a second entrance is at the center of the dam adjacent to powerhouse unit 11, and a third entrance is at the powerhouse service bay between turbine unit 1 and the west shoreline. Fish pass from the entrances into fish collection and transportation channels, which converge to guide fish to a pool and weir fish ladder. There is a counting station at the fishway exit located near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cubic feet per second (cfs). A gravity intake provides additional attraction water for the spillway entrance. The juvenile fish bypass system (JBS) includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

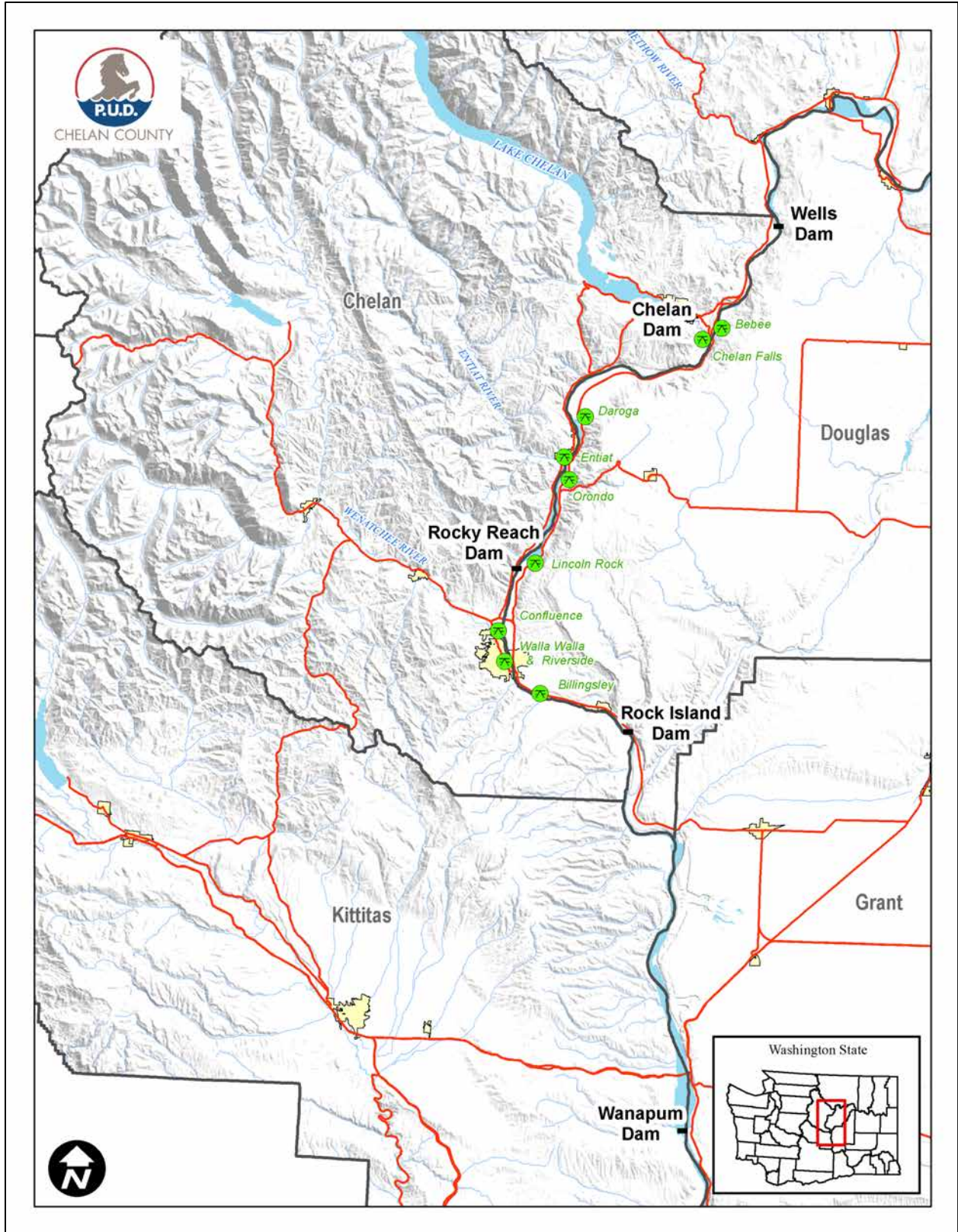


Figure 1-1. Location of Rocky Reach Project on the Columbia River

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington, and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2017 flows at the Rocky Reach Project is shown below in Figure 1-2.

Mean daily discharge during the 2017 fish spill season was compared to the 10-year average of mean daily discharge from 2007-2016, as measured at Rocky Reach Dam. Over the entire fish spill season, mean daily flow discharges during 2017 were greater than the 2007-2016 average (about 120.2% of average at Rocky Reach Dam). The average flows for April, May, and June were greater than the 10-year average and the average flows for July and August were lower than the 10-year average. The maximum daily average observed at Rocky Reach Dam was 269.2 kcfs on May 17, 2017. Of the 153 days during the spill season (April 1 through August 31), there were 9 days when the daily average flow exceeded the seven-day, ten-year frequency flood stage (7Q10) value (252 kcfs) at Rocky Reach Dam.

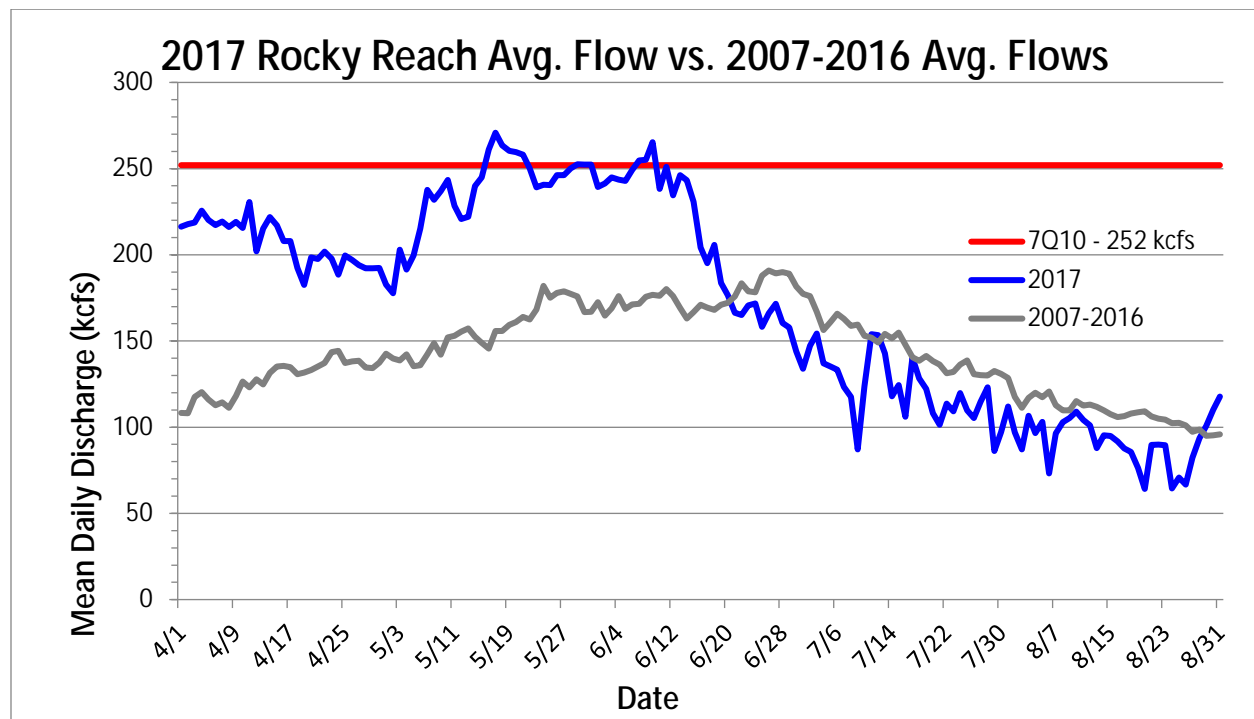


Figure 1-2. Comparison of 2017 vs. previous 10-year average (2007-2016) of mean daily discharge at Rocky Reach Dam

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

WAC 173-201A-200(1)(f) addresses standards for the surface waters of Washington State. Under Washington State water quality standards, TDG shall not exceed 110 percent at any point of measurement in any state water body; however, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when an Ecology-approved GAP is in place. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, a temporary criteria adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG criteria adjustment. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any 1-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive hourly readings (12C-High) in any one day (24-hour period). 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 fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

1.3.2 Fish Spill Season

Section 5.4.2 of the Rocky Reach WQC defines the fish spill season (for downstream migrating juveniles) as April 1 through August 31 of each year. The non-fish spill season is defined as September 1 through March 31, unless otherwise specified in writing to Ecology following consultation with the Rocky Reach Fish Forum (RRFF) and the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) Coordinating Committee (HCP CC).

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rocky Reach Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows – 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds 7Q10. The 7Q10 flood flow for the Rocky Reach Project was calculated to be 252 thousand cubic feet per second (kcfs) (Pickett et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River, which set TDG allocations for each dam (Pickett et al., 2004). With the option for a temporary TDG criteria adjustment under an Ecology-approved GAP, the TMDL set TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations (FMSs). Non-fish passage allocations must be met in all

locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

Section 5.4.7 of the Rocky Reach WQC states: *“This certification, along with the WQMP and the updated GAP, is intended to serve as the Rocky Reach Project’s portion of the Detailed Implementation Plan (DIP) for the Mid-Columbia River and Lake Roosevelt TDG TMDL”.*

1.4 Project Operations

The Rocky Reach Project operates within the constraints of its FERC regulatory and license requirements, as well as other plans and agreements. Chelan PUD plans to implement the following operational measures at Rocky Reach Dam:

1. Minimize voluntary spill – no fish (voluntary) spill planned for the spring migration, 9 percent of the daily average river flow for the summer migration
2. Manage voluntary spill levels during fish passage in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B)
3. Minimize spill, to the extent practicable, by scheduling maintenance based on predicted flows
4. Avoid spill, to the extent practicable, by continuing to impose minimum generation limits on the hydroelectric projects
5. Maximize powerhouse discharge as appropriate up to 212 kcfs
6. Continue the analysis of the three alternate spillway configurations that were tested in 2011 and 2012 (Chelan PUD 2013) to determine if any would be efficient at minimizing TDG. Chelan PUD is currently in the process of writing the program for gate operation to implement the flattened spill gate configuration during the non-fish spill period.

1.4.1 2018 Rocky Reach Operations Plan

Article 402 of the Rocky Reach License requires an annual Operations Plan be submitted to the FERC by February 15 each year for approval (revised submittal date of March 30). This Operations Plan includes the following: (a) descriptions of fisheries (juvenile and adult) and water-quality-related operating criteria for the Rocky Reach Project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (b) descriptions of fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the Rocky Reach Project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (c) an annual schedule for operation and inspection of these facilities. The information contained in the annual Operations Plan is relevant to Chelan PUD's TDG abatement activities and is therefore attached for reference as Appendix C to this GAP.

1.4.2 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rocky Reach Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rocky Reach Project on salmon and steelhead.

The Rocky Reach HCP serves as the foundation for the fisheries management plan at Rocky Reach Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the species named within the HCP, to the “maximum extent practicable” as required by the Endangered Species Act (ESA). HCP species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and Coho salmon. The Rocky Reach HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Rocky Reach Project, including spill and the use of the JBS. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rocky Reach while operating the JBS exclusively.

1.4.3 Other International and Regional Agreements

The Columbia River is managed, and the Rocky Reach Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- **Columbia River Treaty:** An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.
- **Pacific Northwest Coordination Agreement:** An agreement among the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.
- **The Federal Columbia River Power System (FCRPS) Biological Opinion:** by NMFS, applies to actions by the USACE, the USBR, and BPA for impacts on ESA-listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Rocky Reach Project.
- **Hanford Reach Fall Chinook Protection Program Agreement:** The three mid-Columbia PUDs, National Oceanic and Atmospheric Administration (NOAA) Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CCT), and BPA have agreed to river flow management actions to support Public Utility District No. 2 of Grant County’s (Grant PUD’s) effort to manage the flow in the Hanford Reach to protect

fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.4 Spill Operations

1.4.4.1 Spill Gate Configuration

The standard (fish) spill configuration used at Rocky Reach uses gates 2 through 8 with a minimum discharge per spill bay of about 4 kcfs. The standard spill configuration was designed to create a crown-shaped pattern of turbulent flow below the spillway with decreasing velocities leading toward the upstream migrating adult fishway entrances.

This spill pattern provides favorable guidance conditions for adult migrant salmon and steelhead. This spill configuration and alternate patterns were tested and it was determined this pattern was as good as, if not better than, the alternate patterns for upmigrating salmonids (Schneider and Wilhelms 2005). The same pattern is used for juvenile downstream migrating fish passage spill. During spill operations, whether for juvenile fish passage, TDG management, or for other purposes, the gates are operated via a computer-automated system that follows the spill pattern.

Note that although the above-referenced crown-shaped pattern may be as good as, if not better, than tested alternate patterns for upmigrating salmonids, it may not be ideal for TDG. According to Section 5.4(1)(b)(6) of the Rocky Reach WQC, Chelan PUD shall study alternative spillway operations using any of gates 2 through 12. In 2011 and 2012, Chelan PUD studied alternative spillway flow distribution patterns to evaluate the potential to reduce TDG levels, particularly during high spill levels (above 50 kcfs). Generally, all of the three alternative spill patterns studied resulted in lower TDG levels than the standard spill pattern. Of the three alternative patterns, the flat spill pattern (flow distributed evenly between spillway gates) had a slightly better TDG performance than the other two alternative patterns. Chelan PUD has presented these findings to Ecology, the RRFF, and the HCP CC.

Chelan PUD, through the consultation process with Ecology, the RRFF, and the HCP CC, has developed a schedule to make the necessary changes to perform the new flat spill configuration. During the spring of 2016, computer programming of gates 9 through 12 for automated use occurred and the flat spill configuration began at the end of 2016. The gate configuration will only be used during the non-fish spill season. Chelan PUD will operate the new spill configuration as a pilot or test spill and further evaluate the results for a designated period of time. If, on operation of the new spill configuration, data show that optimal results are not occurring as previously evaluated, Chelan PUD shall implement adaptive management in coordination with the RRFF and HCP CC. If operation under the new spill configuration provides significant reduction in TDG, Chelan PUD will incorporate the spill configuration into its regular operations during the non-fish spill season.

1.4.4.2 Spill Scenarios

There are seven main scenarios that may result in spill at Rocky Reach Dam. These are, but are not limited to the following:

1. Fish Spill

Spill is an ineffective method of bypassing downstream migrating juvenile fish away from the turbines at Rocky Reach Dam (Steig et al., 1997) and, consequently, is not considered as the solution for the long-term fish passage program. To minimize or eliminate the need for fish spill, Chelan PUD is focusing its efforts on increasing the fish passage efficiency and survival through the JBS.

The JBS continues to be the most efficient non-turbine route for downstream migrating juvenile fish passage at the Rocky Reach Project. The JBS does not require spill for its operation.

Spring Fish Spill Operations

Operating the JBS exclusively, Chelan PUD has been able to meet the HCP survival standards for the three spring migrants (spring/yearling Chinook, steelhead, and sockeye). Chelan PUD will continue operating the JBS exclusively, with no voluntary spill, during the spring of 2018.

Summer Fish Spill Operations

Summer spill at Rocky Reach Dam for subyearling Chinook will be 9 percent of day average flow. Commencement of summer spill will be determined using run-timing information at Rocky Reach. Summer spill generally begins in late May and ends in mid-August when 95 percent of the migration of subyearling Chinook has passed the Rocky Reach Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

2. Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Rocky Reach Project occasionally forces Chelan PUD to spill water past the Rocky Reach Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license (707 feet), to prevent overtopping of the Rocky Reach Project, and to maintain optimum operational conditions. When spilling for fish or due to excess inflow or generation, the spillway is operated using gate settings that have been shown to limit TDG production and meet fish passage requirements (Schneider and Wilhelms 2005). To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Rocky Reach Project.

3. Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

4. Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

5. Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. FERC requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Rocky Reach Project.

6. Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Rocky Reach Project.

7. Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the-river projects such as Rocky Reach Project.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Rocky Reach Project.

1.5 Spill and Total Dissolved Gas Compliance – Previous Year 2017

1.5.1 Spill

In 2017, spill events at Rocky Reach Dam were involuntary (forced) April 1 through May 25 and both voluntary and involuntary May 26 through August 25 (summer fish spill period). Between April 13 and May 25, 15 percent of the spill was forced. Between May 26 and the end of summer fish spill on August 25, 9.06 percent of the total volume spilled was voluntary, while 12.68 percent was involuntary (forced) spill due to large volumes of water and repairs on units with mechanical issues discovered in 2013. Information regarding spill for the 2017 fish spill season are displayed in Table 1-1 and Appendix D.

Table 1-1. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2017

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish Spill			Other		
			Spill kcfs	Percent of Flow	Percent of Total Spill	Spill kcfs	Percent of Flow	Percent of Total Spill
April	207.2	74	0.0	0.0	0.0	74.0	35.7	100.0
May	236.1	88.2	4.1	1.7	25.2	84.1	35.6	95.4
June	209.2	59	19.5	9.3	99.8	39.5	18.9	66.9
July	121.9	13.0	11.5	9.5	87.6	1.5	1.2	11.4
August	91.3	7.1	6.3	6.9	92.3	0.8	0.8	10.9

1.5.2 Total Dissolved Gas Compliance 2017

Over the course of the 2017 fish spill season, there were 59 exceedances of the TDG numeric criteria in the Rocky Reach Tailrace (RRTR) and 4 exceedances in the Rock Island Forebay (RIFB). There were 732 and 0 hourly exceedances of the 125 percent numeric criteria in the RRTR and RIFB, respectively.

Table 1-2 displays the total number of times TDG levels exceeded the current WQS during the 2017 fish spill season as measured at each of Chelan PUD’s FMS applicable to the Rocky Reach Project. The total number of exceedances also reflects the omission of exceedances caused by the previous day’s hourly values, if those same hourly values also created a 12-hour average TDG value above standards for the previous day.

Table 1-2. Summary of hourly averages total dissolved gas measurements from each FMS during the 2017 fish spill season

Location ¹	Number of 115/120 Percent Exceedances					Number of 125 Percent Exceedances		
	Spring Spill	Summer Spill	Total	Total # of Days ²	Percent Below Standard	Total Hours	Total # of Hours ²	Percent Below Standard
RRTR	42 ³	17 ⁴	59	153	61.4	3,672	732 ⁷	80.1
RIFB	4 ⁵	0 ⁶	4	153	97.4	3,668	0	100.0
Total	45	17	63	306	79.4	7,340	732	90.0

Notes:

¹ RRFB = Rocky Reach Forebay, RRTR = Rocky Reach Tailrace, RIFB = Rock Island Forebay.

² Based on total number of available days/hours minus days/hours omitted due to TDG membrane failures or other QA/QC issues.

³ 53 days of the 55 days (April 1 – May 25) of RRTR Spring Spill 12C-High TDG values exceeded the 120 percent standard; however, the daily 12C-High flows exceeded 7Q10 for 11 days.

⁴ 27 days of the 98 days (May 26 – August 31) of RRTR Summer Spill 12C-High TDG values exceeded the 120 percent standard; however, the daily 12C-High flows exceeded 7Q10 for 10 days.

⁵ 49 days of the 55 days of RIFB Spring Spill had 12C-High TDG values greater than 115 percent; however, 45 days were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RRFB and/or 12C-High flows exceeded 7Q10 at Rock Island Dam.

⁶ 30 days of the 98 days of RIFB Summer Spill 12C-High TDG values exceeded the 115 percent standard; however, all 30 days of RIFB 12C-High TDG values were not counted as an exceedance because incoming TDG levels were above the 115 percent standard in the RRFB and/or 12C-High flows were exceeded 7Q10 at Rock Island Dam.

⁷ A total of 1,285 RRTR hours exceeded the 125 percent standard; however, 553 of those 1,285 hourly exceedances occurred when the daily 12C-High and hourly flows exceeded 7Q10 at Rocky Reach Dam.

1.5.3 TDG Activities Implemented in 2017

In 2017, Chelan PUD implemented four actions to minimize voluntary and involuntary spill at Rocky Reach Project to meet TDG water quality standards. The primary operational action to reduce spill at the Rock Reach Project was the implementation of the operational spill programs and the ability to minimize spill through success of survival studies. These efforts included the following:

- Minimizing voluntary spill
- Managing voluntary spill levels during fish passage in real time to meet TDG numeric criteria
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows
- Maximizing powerhouse discharge as appropriate up to 212 kcfs.

1.5.4 TDG Structural Measures Implemented in 2017

No structural gas abatement measures were proposed or implemented at the Rocky Reach Project in 2017.

2.0 Proposed 2018 Action Plan to Achieve TDG Standards

The following sections describe TDG abatement measures proposed for implementation during 2018 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Section 5.4.1(b) of the Rocky Reach WQC requires Chelan PUD to manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and Anadromous Fish Agreement.² During the 2018 fish spill season, Chelan PUD proposes to use a combination of the following measures, as needed, to meet water quality criteria for TDG:

1. Minimize voluntary spill

Success of the JBS has enabled Chelan PUD to reduce spill required for fish passage.

2. Manage voluntary spill in real time

During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B). The TDG Operational Plan is updated annually and routed to the Rocky Reach Project operators. It provides the operators a list of actions they are to follow if TDG meets the designated thresholds.

3. Minimize involuntary spill

Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. Maximize powerhouse discharge as appropriate up to hydraulic capacity

5. Implement alternative spillway operation

Chelan PUD plans to continue implementation of the flattened spill configuration during the non-fish spill season in a test or pilot mode for further evaluation of TDG reduction.

2.2 Proposed Structural TDG Abatement Measures and Technologies

Per Section 5.4(5) of the Rocky Reach WQC, operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

² Additional conditions used to determine compliance with the water quality criteria for TDG can be found in Sections 5.4(1)(d)-(g) of the Rocky Reach WQC, as well as Section 4.4 of this Plan.

No structural gas abatement measures are planned at the Rocky Reach Project in 2018. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

3.0 Physical and Biological Monitoring and Quality Assurance

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a Quality Assurance Project Plan (QAPP).

3.1 Fixed-Site Monitoring Station for TDG

Chelan PUD currently maintains two FMSs at the Rocky Reach Project to monitor hourly TDG levels annually. The FMS are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rocky Reach forebay FMS (Figure 3-1) is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The Rocky Reach tailrace FMS (Figure 3-1) is located approximately 0.38 miles downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is east of mid-channel and is minimally impacted by powerhouse flows when the Rocky Reach Project is passing water over the spillway (Schneider and Wilhelms 2005).

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental to perform calibrations and equipment maintenance during the 2018 monitoring season. Calibration and equipment maintenance will be conducted monthly throughout the year. Quality assurance/quality control (QA/QC) measures will be accomplished through training in instrument maintenance, operation, and factory-prescribed calibration methods. A detailed log will be maintained for all work done on the monitoring equipment, including monthly maintenance, calibration, exchange of instruments, and any other pertinent information.

TDG levels are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on the website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page.³

³ The website for the USACE, Columbia River Basin Water Management Division, Rock Island Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg. Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.



Figure 3-1. Location of forebay and tailrace FMSs at Rocky Reach Dam

3.2 Quality Assurance

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

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as Hydro Lab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's QAPP (Appendix D) per Section 5.7(2) of the Rocky Reach WQC.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

Gas bubble trauma (GBT) monitoring is not conducted on an annual basis at Rocky Reach Dam; however, Section 5.4(1)(c) of the Rocky Reach WQC (Ecology 2006) requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. On April 21, 2014, Chelan PUD received a letter from Ecology postponing the GBT monitoring until such a time as is determined to be appropriate by Ecology. Ecology is currently evaluating the need for future GBT studies below Rocky Reach Dam. Currently, Chelan PUD conducts a Smolt Monitoring Program at Rock Island Dam.

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct GBT monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead, and subyearling Chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC 2014). The results of this monitoring effort will be included in a TDG annual report (see Section 4.3 Annual Report).

4.0 TDG Compliance Reporting Methods

4.1 Water Quality Website

Section 5.7.6 of the Rocky Reach WQC requires hourly TDG information be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on the website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page.⁴

4.2 Notifications

Chelan PUD shall notify Ecology, the Central Regional Office, and the Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.3.2 Fish Spill Season, and any deviation from the TDG Operational Plan (Appendix B) or the fish spill plan that adversely affects TDG levels. This notification may be either electronically or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft TDG annual report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Report will include the following:

- Flow over the preceding year (cfs over time)
- Spill over the preceding year (cfs and duration)
- Reasons for spill (e.g., for fish, turbine down time)
- TDG levels during spill (hourly, to include fish spill season)
- Summary of exceedances and what was done to correct the exceedances
- Results of the fish passage efficiency studies and survival per the HCP
- Result of biological monitoring (GBT) at Rock Island Bypass Trap (conducted in conjunction with the FPC)
- Results of QA/QC implementation

⁴ The website for the USACE, Columbia River Basin Water Management Division, Rock Island Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg. Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.

- Analysis of monitoring data for confirmation or refinement of the regression equations in the Water Quality Management Plan (WQMP)⁵ used to predict compliance with TDG numeric criteria.

The analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG numeric criteria will include the following steps:

- Input relevant 2008 (post relocation of tailrace fixed monitoring site) and 2009-2017 data
- Analyze to see if the relationship between quantity of spill and TDG yields a similar or different regression than that predicted for site FOP1 (located just downstream and landward of the current tailrace monitoring site [Figure 2]) in Schneider and Wilhelms (2005)
- If regression is different, look for patterns that may explain the difference
- Determine if any differences in the regression affect the predictions in Schneider and Wilhelms (2005) to meet TDG standards up to 7Q10 flows.

4.4 Determination of Compliance in Year 5

As per Section 5.4(1)(d) of the Rocky Reach WQC, in Year 5 of the effective date of the License, Chelan PUD shall prepare a report summarizing the results of all TDG studies performed to date and describing whether compliance with the numeric criteria has been attained. This report was submitted as a Draft to Ecology and the RRF on October 31, 2014, and the HCP CC on November 25, 2014. The HCP CC requested an additional 30-day comment period extending the final due date to Ecology on January 30, 2015. Ecology approved the extension and final due date. Comments were received and incorporated into the final report submitted to Ecology on January 30, 2015. In a letter to Chelan PUD, dated July 15, 2015, Ecology determined that full compliance with the applicable numeric criteria for TDG had not been met and that aquatic life is not adversely affected at the Rocky Reach Project. Section 5.4(1)(d) further states that Chelan PUD shall prepare a report that evaluates operational or structural measures to further reduce TDG. On March 1, 2017, Chelan PUD provided such report to Ecology. After providing a 30-day comment period, Ecology responded that they did not have any comments.

⁵ The WQMP is a response to Ecology's request that the PUD provided the scientific and biological basis for Ecology's WQC. It is the principal supporting document for the Rocky Reach WQC. As stated in Chapter 2 of the Comprehensive Plan (Attachment B to the Rocky Reach Settlement Agreement):

“Ecology is a participant in the Settlement Group negotiating conditions for relicensing of the Project, and has requested that Public Utility District No. 1 of Chelan County (Chelan PUD) help provide the scientific and biological basis for Ecology’s Section 401 Certification. The Settlement Group has developed a Comprehensive Plan that provides the rationale and details behind proposed license articles that the Settlement Group will recommend for inclusion in the New License to be issued by FERC. The Rocky Reach Water Quality Management Plan is in response to Ecology’s request and is contained in this chapter of the Comprehensive Plan.”

The WQMP includes Project background; background water quality; management considerations and options investigated; and protection, mitigation, and enhancement measures.

5.0 Updates to the Gas Abatement Plan

As per Section 5.4(3) of the Rocky Reach WQC, the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

Additionally, beginning in year 10, and every 10 years thereafter, the revised annual GAP shall include a review of reasonable and feasible gas abatement options to incrementally reduce TDG caused by the Rocky Reach Project, in light of new information and technology. If any reasonable and feasible measures are identified, Chelan PUD shall present the data and analysis to the RRF and develop an implementation plan. The implementation plan shall be included in the GAP for review and approval by Ecology.

6.0 Conclusions

Chelan PUD shall implement the measures presented in Section 2.0 of this 2018 GAP. Implementation of these measures are intended to ensure compliance with the WAC for TDG in the Columbia River at the Rocky Reach Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Anadromous Fish Agreement. No structural gas abatement measures are planned at the Rocky Reach Project in 2018. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

7.0 List of Literature

- Federal Energy Regulatory Commission (FERC). 2009. Order on Offer of Settlement and Issuing New License, Project No. 2145-060.
- Fish Passage Center (FPC). 2014. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, Oregon.
- National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.
- Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.
- Schneider, M.L. and S.C. Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. Prepared by COE, Engineer Research and Development Center, for Chelan PUD. July 2005.
http://www.chelanpud.org/rr_relicense/study/reports/7773_1.pdf
- Steig, T.W., R. Adeniyi, and V. Locke. 1997. Hydroacoustic evaluation of the fish passage through the powerhouse, the spillway, and the surface collector at Rocky Reach Dam in the spring and summer of 1997. Report by Hydroacoustic Technology, Inc. to Chelan Co. PUD, Wenatchee, Washington.
- Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCKY REACH HABITAT CONSERVATION PLAN

APPENDIX B: 2018 ROCKY REACH TDG OPERATIONAL PLAN

**2018 Rocky Reach Operational Plan
for Total Dissolved Gas (TDG) During Fish Spill Season**

April 1 through August 31

(All spills between these dates are subject to the actions contained in this plan.)

(Applies only when not spilling for headwater control.)

Protocol

1. If tailrace TDG average is greater than **120% for the 6-hour average**
 - reduce spill by 3 kcfs
 - monitor for 1 hour
 - if the 6-hour average TDG >120%, reduce spill by another 2 kcfs
 - monitor for 1 hour
 - continue reducing spill by 2 kcfs until 6-hour average TDG is less than 120% for 1 full hour
 - **if after reducing spill to control TDG levels, TDG drops below 118% for 1 full hour, increase spill by 2 kcfs and monitor****
2. If tailrace TDG is greater than **125% for 1 hour**
 - follow protocol outlined above, but instead, use 1-hour TDG levels of 125% as the metric
 - continue until TDG is less than 125% for 1 hour and until the 6-hour average TDG <120%

RI TDG Compliance: If you receive a call from RI advising that the RI forebay is out of compliance (greater than 115%) and the RR forebay is 115% or less, reduce spill by 3 kcfs. Two hours after reducing spill, call RI to determine what the RI forebay gas levels are. If still above 115%, reduce spill another 2 kcfs. If after reducing spill for this reason, the Rock Island forebay drops to less than 113%; Rock Island will call again and advise. At this point, increase back to the hourly spill volume target by increasing spill in the reverse order it was decreased. For example, if to bring the RI forebay back into compliance, it was necessary to reduce spill by a total of 5 kcfs, begin by increasing spill by 2 kcfs, wait two hours, and call RI to determine what the forebay TDG levels are. If TDG is still below 115%, increase spill by 3 kcfs (back to the target volume in this case). This will allow for a ramping effect, rather than an open/shut effect which could bump the Rock Island forebay TDG levels back out of compliance (>115%).

**** Note:** It will not be necessary to monitor for 1 full hour after re-opening gates if it appears that TDG is approaching the upper threshold, rather, the procedure will repeat upon reaching the threshold. It is anticipated that in time, the operators will “get a feel” for how much change in TDG will occur as a result of opening or closing gates and it will be possible to hold the TDG around 118% or 119% or so. Once the operators have this down, instead of closing a gate entirely, it may only be necessary to close partially and vice versa for the opening process.

APPENDIX C: 2018 OPERATIONS PLAN

APPENDIX D: 2010 QUALITY ASSURANCE PROJECT PLAN

APPENDIX E: 2017 TOTAL DISSOLVED GAS ANNUAL REPORT

APPENDIX F: RESPONSE TO COMMENTS
