Grant County
PUBLIC UTILITY DISTRICT

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January 3, 2018

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12
888 First Street, N.E.
Washington, D.C. 20426

Re: **Priest Rapids Hydroelectric Project No. 2114-169 License Compliance Filing: Article 401 (a)(19) – 2018 Gas Abatement Plan**

Dear Secretary Bose:

Please find enclosed Public Utility District No. 2 of Grant County, Washington's (Grant PUD's) 2018 Total Dissolved Gas Abatement Plan (GAP) consistent with the requirements of Article 401(a)(19) of the Priest Rapids Hydroelectric Project License[1] and associated obligations and mandates, including the Washington Department of Ecology (WDOE) 401 Water Quality Certification (WQC). Specifically, the 401 WQC requires that the GAP be revised annually to reflect any changes required in accordance with the 401 WQC, that the draft GAP be submitted to WDOE annually for review on or before October 31, and that the GAP is to be finalized by February 1 of the following year. This 2018 GAP is an update to the 2017 GAP. The GAP requirement is also referenced in the 2008 Biological Opinion, Salmon and Steelhead Agreement, and the fishway prescriptions submitted by both the National Marine Fisheries Service (NMFS) and the U.S. Fish & Wildlife Service (USFWS) relating to the Priest Rapids Project License.

Grant PUD prepared and disseminated for comment a draft GAP to WDOE, the Priest Rapids Coordinating Committee (PRCC), the National Marine Fisheries Service (NMFS), the United States Fish and Wildlife Service (USFWS) on October 31, 2017. Comments were requested by December 30, 2017. No comments were received.

The final GAP includes the following appendices, including:

- Appendix A: 2017 fish-spill and total dissolved gas monitoring report: required under section 6.4.11(c) of the 401 WQC (submitted to WDOE October 31, 2017.).
- Appendix B: 2009 Quality Assurance Project Plan (QAPP); required under Section 6.7.1 of the 401 and Article 401(a)(23) of the FERC license (approved by WDOE and FERC on January 30, 2009 and July 26, 2009, respectively).

[1] 123 FERC ¶ 61,049 (2008)

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FERC staff with any questions should contact me at 509-793-1468 or rhendr1@gcpud.org.

Sincerely,

Ross Hendrick
License Compliance Manager

CC: David Bowen – WDOE
Breean Zimmerman – WDOE
PRCC Members
Wanapum

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Priest Rapids Hydroelectric Project (P-2114)

2018 Total Dissolved Gas Abatement Plan

License Article 401(a)(19)

By Carson Keeler

Public Utility District No. 2 of Grant County, Washington
Priest Rapids Project

FERC Project Number 2114

January 2018

Executive Summary

This draft total dissolved gas abatement plan (GAP) provides details on operational and structural measures that the Public Utility District No. 2 of Grant County, Washington (Grant PUD) plans to implement as part of its fish-spill program for the year 2018. These measures are intended comply with Washington State's water quality standards for total dissolved gas (TDG) at the Priest Rapids Hydroelectric Project (Project). The Washington Department of Ecology (WDOE) establishes Washington state water quality standards for TDG during the non-fish and fish-spill seasons. This current year's GAP (2018) is an update to the 2017 GAP submitted to the WDOE and the Federal Energy Regulatory Commission (FERC) on February 27, 2017.

Proposed operational abatement measures include minimizing involuntary spill by scheduling maintenance operations based on predicted flows and maximizing turbine flows by setting minimum generation requirements to power purchasers. Operational abatement measures also include the participation in regional operators meetings to discuss potential TDG abatement measures, coordination of regional spill amounts and locations, and implementation of preemptive spill to avoid periods of high involuntary spill. In addition, Grant PUD will consult with WDOE on any non-routine operational changes that may affect TDG, as well as manage fish-spill programs to meet TDG water quality standards through coordination with the Priest Rapids Coordinating Committee (PRCC).

Structural TDG abatement measures include operation of both the Wanapum and Priest Rapids Fish Bypasses (WFB and PRFB), which are both designed to safely pass juvenile outmigrating salmonids while minimizing TDG uptake (Hendrick et. al 2009 and Keeler 2016). The installation of the advanced turbine systems at Wanapum Dam has been completed, with the final unit installed in October of 2013. Additionally, in accordance with the terms and conditions contained in the 401 WQC (WDOE 2007) Grant PUD conducted TDG evaluations with all 10 advanced turbines in operation in October of 2013 in accordance with the Wanapum Dam Advanced Turbine Total Dissolved Gas Evaluation (see Keeler 2012c), to determine the impact, if any, the operation has on TDG. Results from these evaluations are presented in Keeler 2014a and were submitted to the WDOE/PRCC and the FERC on December 13, 2013 and February 20, 2014, respectively.

Compliance monitoring for TDG will continue at Grant PUD's fixed-site monitoring stations (FSM stations). TDG data will be collected on an hourly basis throughout the year and will be reported to Grant PUD's water quality web-site (http://www.grantpud.org/environment/water-quality/monitoring-data). An annual report to WDOE will summarize Grant PUD's TDG monitoring and fish-spill season results.

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Terms and Abbreviations

2004 Biological Opinion	National Marine Fisheries Service 2004 Biological Opinion for the Priest Rapids Project
7Q10 flow	highest seven consecutive day average flow with a 10-year recurrence frequency
Biological Opinion	National Marine Fisheries Service 2008 Biological Opinion for the Priest Rapids Project
Chelan PUD	Public Utility District No. 1 of Chelan County, Washington
Corps	US Army Corps of Engineers
DO	dissolved oxygen
ESA	Endangered Species Act
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County, Washington
FERC	Federal Energy Regulatory Committee
FSM	fixed-site monitoring
kcfs	thousand cubic feet per second
MOA	Memorandum of Agreement
MW	megawatt
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
PRFB	Priest Rapids Fish Bypass
PRCC	Priest Rapids Coordinating Committee
PRFF	Priest Rapids Fish Forum
Project	Priest Rapids Hydroelectric Project
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RPA	Reasonable and Prudent Alternative
TG	tainter gate
TDG	total dissolved gas
TMDL	total maximum daily load
USGS	U.S. Geological Survey

WAC	Washington Administrative Code
WFB	Wanapum Fish Bypass
WDOE	Washington Department of Ecology
WQC	water quality certification

1.0 Introduction

The Public Utility District No. 2 of Grant County, Washington (Grant PUD) owns and operates the Priest Rapids Hydroelectric Project (Project; Figure 1). The Project is licensed as Project No. 2114[1] by the Federal Energy Regulatory Commission (FERC), and includes the Wanapum and Priest Rapids developments. A 401 water quality certification (WQC) for the operation of the Project was issued by the Washington Department of Ecology (WDOE) on April 3, 2007 (WDOE 2007), amended on March 6, 2008 and effective on issuance of the FERC license to operate the Project in April of 2008 (FERC 2008). Section 6.4.11(e) of the 401 WQC (WDOE 2007) requires Grant PUD to submit an annual total dissolved gas abatement plan (GAP) in accordance with WDOE's water quality standards for total dissolved gas (TDG).

This 2018 draft GAP provides details on operational and structural measures Grant PUD will implement during the 2018 fish-spill season. These measures are intended to comply with WDOE's water quality standards for TDG at the Project.

1.1 Priest Rapids Project Description

The Wanapum development consists of a 14,680-acre reservoir and an 8,637-foot-long by 186.5-foot-high dam spanning the Columbia River. The dam consists of left and right embankment sections; left and right concrete gravity dam sections; a left and right fish passage structure, each with an upstream fish ladder; a gated spillway; a downstream fish passage structure (the Wanapum Fish Bypass (WFB)); and a powerhouse containing ten vertical shaft integrated Kaplan turbine/generator sets with a total authorized installed capacity (best gate) of 735 MW (Figure 2).

The Priest Rapids development consists of a 7,725-acre reservoir and a 10,103-foot-long by 179.5-foot-high dam spanning the Columbia River. The dam consists of left and right embankment sections; left and right concrete gravity dam sections; a left and right fish passage structure, each with an upstream fish ladder; a gated spillway section; a downstream fish passage structure (the Priest Rapids Fish Bypass (PRFB)); and a powerhouse containing ten vertical shaft integrated Kaplan turbine/generator sets with a total authorized installed capacity of 675 MW (best gate) (Figure 3).

The Wanapum and Priest Rapids dam spillways were initially designed to accommodate flows that exceeded turbine (hydraulic) capacity and have more recently been used to spill water for the purpose of supplementing downstream smolt migrations. However, releasing flows over the spillways can also result in elevated TDG, which can be harmful to fish. To address this issue, Grant PUD coordinates its fish-spill program to address fish migrations and comply with current water quality standards for TDG and has implemented downstream bypass measures to safely pass salmonids and/or to reduce or minimize TDG.

[1] 123FERC ¶ 61,049

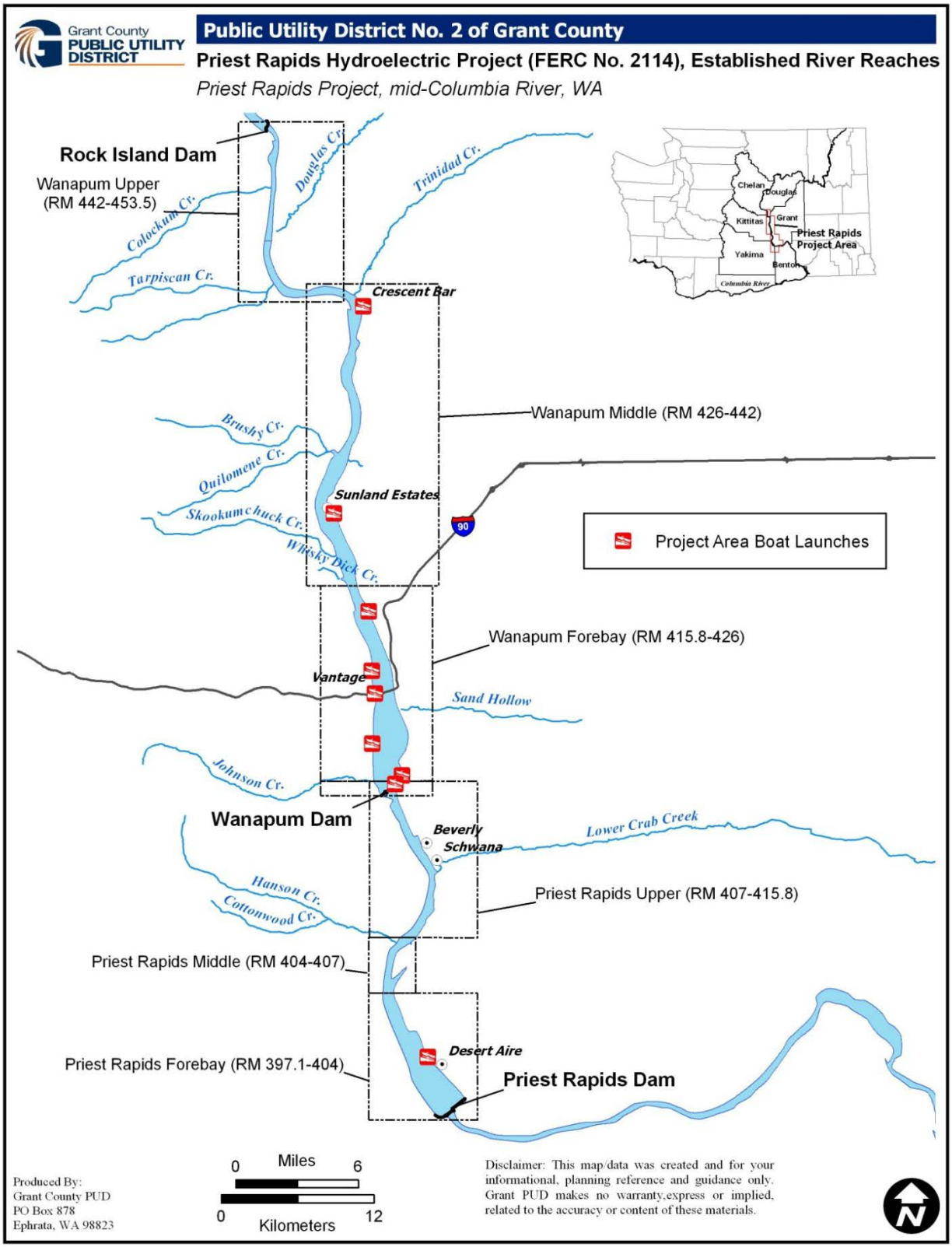

Figure 1 **Priest Rapids Hydroelectric Project and established river reaches presented by river mile (RM), mid-Columbia River, WA.**

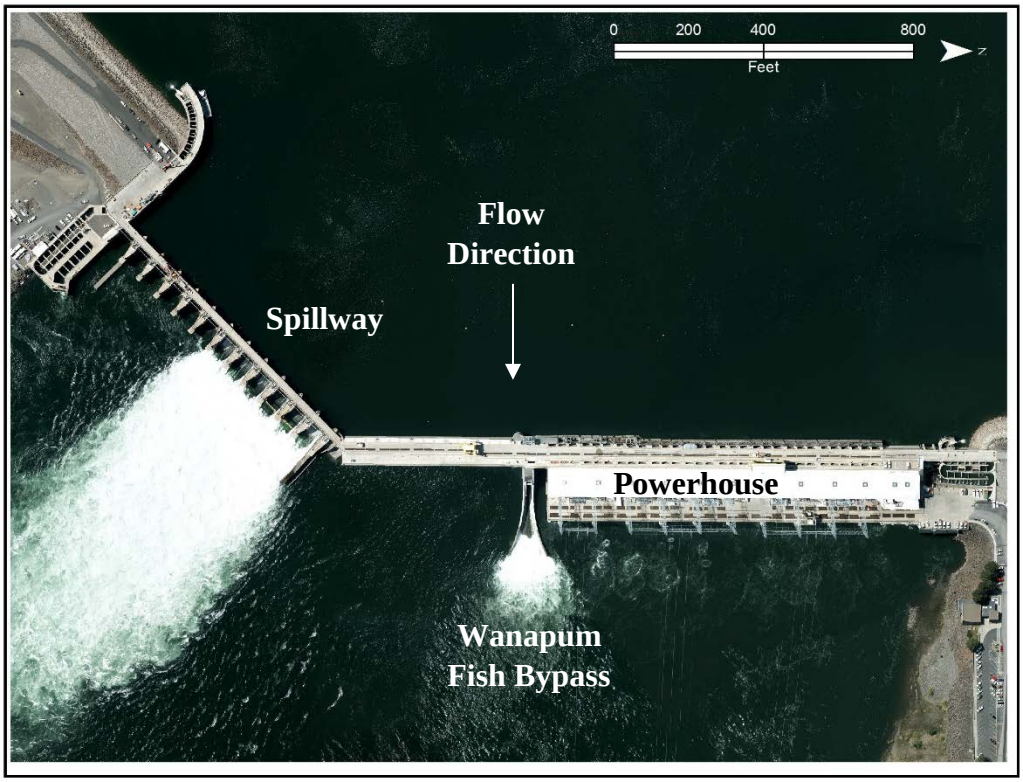

Figure 2 **Aerial photograph of Wanapum Dam, mid-Columbia River, WA.**

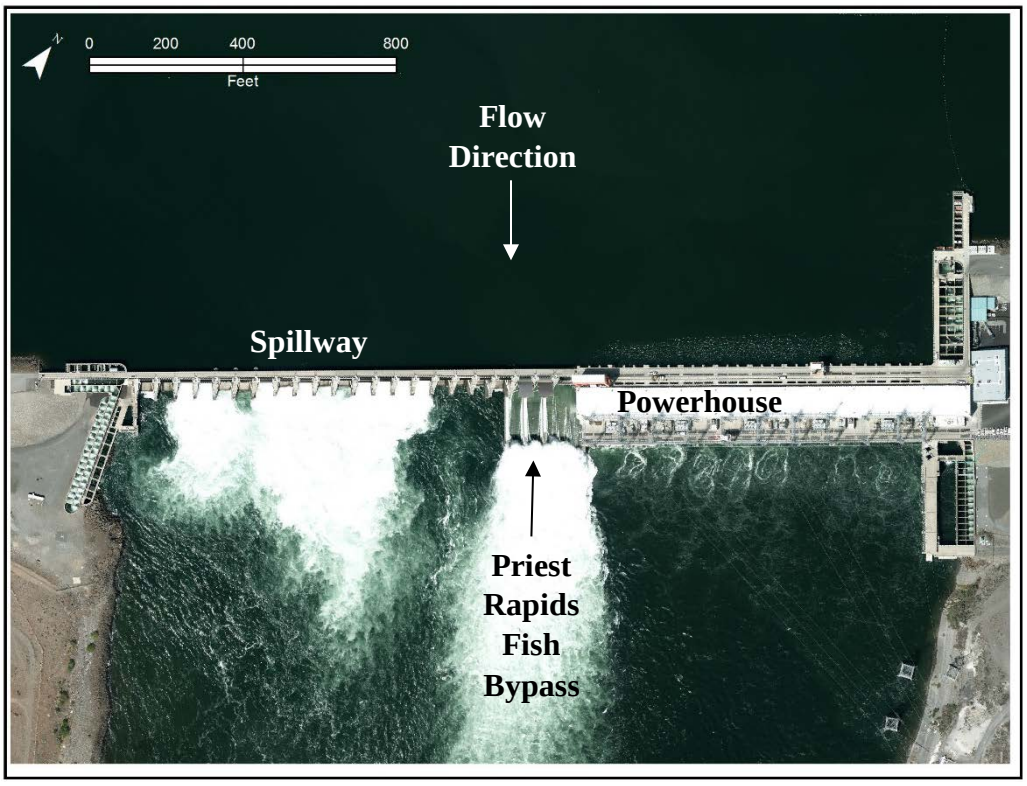

Figure 3 **Aerial photograph of Priest Rapids Dam, mid-Columbia River, WA.**

1.2 Regulatory Framework

Washington state water quality standards are established by WDOE for TDG during the non-fish and fish-spill seasons (see Washington Administrative Code (WAC) 173-201A-200(1)(f)). The current standard for TDG (in percent saturation (%SAT)) during the non-fish spill season (September 1 through March 31) is 110 %SAT for any hourly measurement. The current standard for TDG (in %SAT) during the fish-spill season (April 1 through August 31) is 120 %SAT in the tailrace of the dam spilling water for fish and 115 %SAT in the forebay of the next downstream dam, based on the average of the twelve highest consecutive hourly readings in a twenty-four hour period. A one-hour, 125 %SAT maximum standard for TDG also applies throughout the Project.

It is important to note that the TDG water quality standards identified above are intended to help protect aquatic life designated uses within the Project. This includes WDOE's allowance of higher TDG levels during the fish-spill season which allow dams to spill water to help meet juvenile salmonid passage performance standards. Specific passage performance (or survival) standards for the Project are outlined in the Priest Rapids Project Salmon and Steelhead Settlement Agreement (Grant PUD 2006) and the National Marine Fisheries Service (NMFS) 2008 Biological Opinion (Biological Opinion; NMFS 2008). Specifically, the Biological Opinion provides that Grant PUD make stable progress towards achieving a minimum 91% combined adult and juvenile salmonid survival performance standard at the Priest Rapids and Wanapum developments (i.e. each dam/reservoir). The 91% standard includes a 93% project-level (one reservoir and one dam) juvenile performance standard. Because NMFS recognizes that it is not currently possible to measure the 91% combined adult and juvenile survival standard, NMFS provides that Grant PUD continue to conduct dam and reservoir smolt survival studies, evaluating progress towards meeting a 93% juvenile development passage survival.

Grant PUD is currently using juvenile salmonid survival evaluation studies to evaluate progress toward meeting these survival standards. Structural changes, along with changes in how the dams are operated, are one approach that has been pursued to increase dam passage survival rates. For example, as outlined in a fish passage alternatives study for the Project (Jacobs et. al 2003), the WFB and PRFB were designed to help safely pass downstream fish migrants while still meeting TDG standards. The WFB and PRFB were completed in 2008 and 2014, respectively.

As another example, the Wanapum and Priest Rapids dams turbines are operated in "fish-mode", which has been shown to be the optimal turbine operating range based on turbine fish-survival studies (Normandeau, Skalski and Townsend 2005, Normandeau and Skalski 2005). Additional information related to these changes is presented in Sections 2 and 3 of this 2017 GAP. Achieving the survival standards as described above and in addition to meeting TDG numeric criteria as outlined in WAC 173-201A-200(1)(f), are an integral part of meeting the water quality standards (e.g. protection of designated uses) as described in the Project's 401 WQC (WDOE 2007).

1.2.1 Fish-Spill Season

The fish-spill season is defined by WDOE to occur from April 1 through August 31 of each year (Section 6.4.1(b) of the Project's 401 WQC; WDOE 2007). Actual spill for fish at Wanapum and Priest Rapids dams typically occurs from mid-April through mid-August, depending on the timing of the fish-migrations as documented at the Rock Island Dam smolt index station. Grant

PUD also provides small amounts of spill for adult fallback from the end of the juvenile fish-spill season until November 15, annually.

Prior to 2008, fish-spill quantities and durations had been guided by the NMFS 2004 Biological Opinion (2004 Biological Opinion) on the effects of the proposed interim protection plan for the Project on listed species (NMFS 2004). Yearly fish-spill programs were implemented at the guidance of the Priest Rapids Coordinated Committee (PRCC).

On February 1, 2008 NMFS issued a subsequent Biological Opinion (NMFS 2008) for the Project related to the FERC license (FERC 2008). The Biological Opinion incorporated the conditions contained in the 2004 Biological Opinion as they related to Grant PUD's fish-spill program, and those terms and conditions were incorporated in the FERC license to operate the Project issued on April 17, 2008 (FERC 2008). Reasonable and Prudent Alternatives (RPA) 1, and associated terms and conditions of the Biological Opinion require spill during the fish-spill season in order to aid in the passage of out-migrating juvenile salmonids.

1.2.2 Incoming Total Dissolved Gas Levels

Section 6.4.1(d) of the 401 WQC (WDOE 2007) provides that even when TDG levels in the tailrace of a dam exceed 120 percent, that dam may be deemed in compliance with TDG water quality standards if both the following apply:

- TDG levels in the dam's forebay exceed 120 percent, and
- The dam does not further increase TDG levels in the tailrace

Fixed site water quality monitors are installed in both the Wanapum and Priest Rapids dams' forebays to identify incoming TDG levels (see Section 4.1).

1.2.3 7Q10 Flows

Section 5.0(b) of the 401 WQC (WDOE 2007) and WAC 173-201A-200(f)(i) provide that the TDG water quality standard for both Wanapum and Priest Rapids dams shall be waived if flows exceed the "7Q10 flood flow," which is the highest seven consecutive day average flow with a ten-year recurrence frequency. The 7Q10 flood flow was calculated to be 264 thousand cubic feet per second (kcfs) for both Wanapum and Priest Rapids dams.

1.2.4 Total Dissolved Gas Total Maximum Daily Load

In 2004, WDOE established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (WDOE 2004). According to section 6.4.1(f) of the 401 WQC, Grant PUD shall be "…deemed in compliance with the TDG TMDL…" while it remains in compliance with the 401 WQC (WDOE 2007).

1.3 Historical Conditions

The following sections provide a brief historical overview of river flows, fish-spill operations, and TDG levels and provides references to previous TDG/Fish-Spill season reports.

1.3.1 Priest Rapids Project Operations

In general terms, the hydropower system and reservoir operations of upstream development operators are coordinated through a set of complex agreements and policies to optimize the benefits and minimize the adverse effects of development operations. The Project operates

within the constraints of its FERC regulatory and license requirements, Pacific Northwest Coordination Agreement, Canadian Treaty, Canadian Entitlement Agreement, Salmon and Steelhead Settlement Agreement, Biological Opinion, and Hanford Reach Fall Chinook Protection Program Agreement.

1.3.2 River Flows

Figure 4 illustrates a ten-year average of mean daily discharge values from 2007 to 2016, as measured at the U.S. Geological Survey (USGS) Stream flow gage #12472800 located 2.6 river miles downstream of Priest Rapids Dam (USGS 2016). During the fish-spill season stream flows typically peak in late May/early June and begin to recede in July.

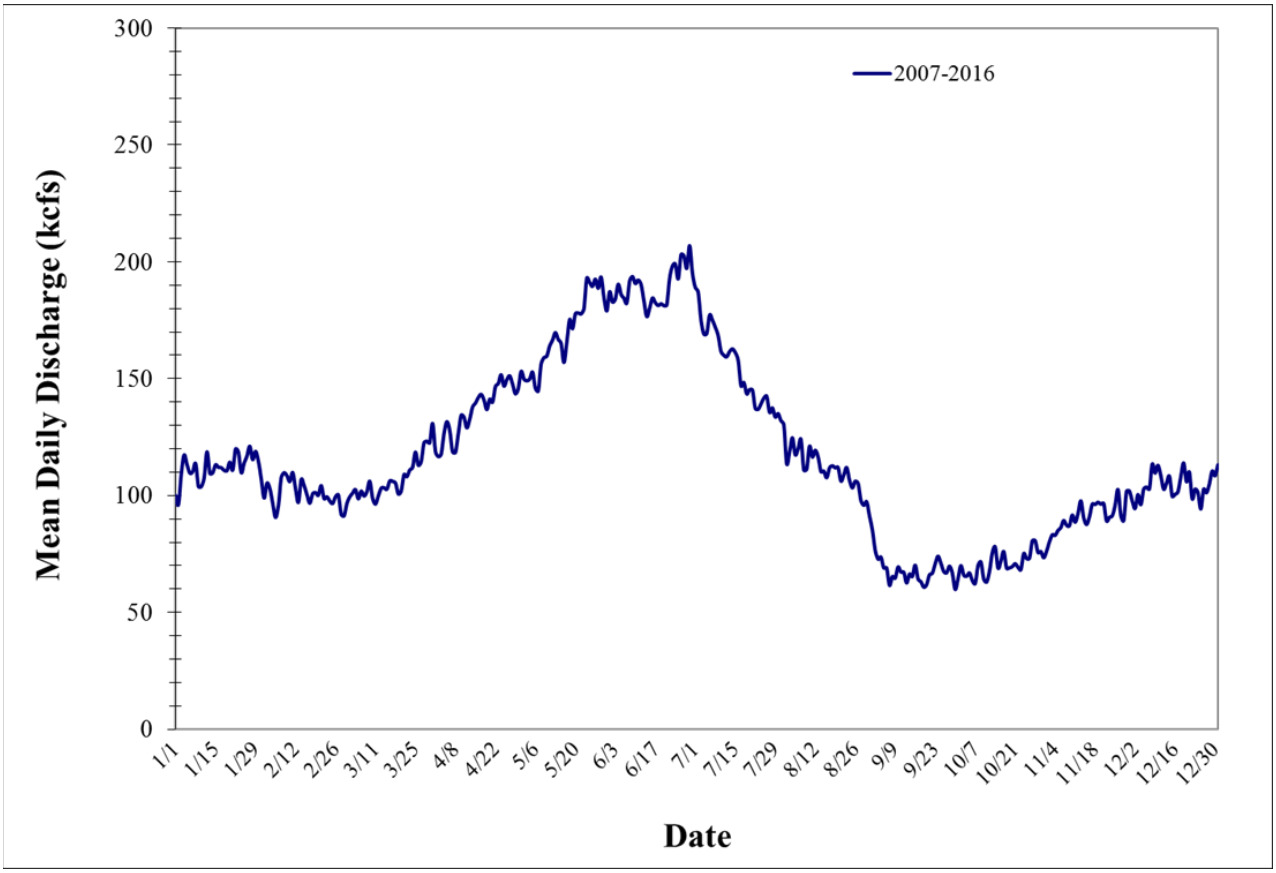

Figure 4 **Ten-year average of mean daily discharge values from 2007 to 2016 as measured at the USGS stream flow gage #12472800 located below Priest Rapids Dam, mid-Columbia River, WA (USGS 2017).**

Water is passed through Wanapum Dam either through the ten powerhouse units, 12 tainter-gates, sluiceway, and/or the WFB (Figure 2 and Figure 5). Maximum flow through each powerhouse unit ranges from 15-18 kcfs, passing 135–162 kcfs of total flow assuming 90% capacity (e.g. one unit out of operation), depending on forebay and tailwater elevations, power market conditions, and presence of out-migrating juvenile salmonids. During the fish-spill season, the turbines at Wanapum Dam are limited to approximately 15.7 kcfs in order to provide optimal passage conditions for migrating salmonids based on turbine survival studies conducted at Wanapum Dam (Normandeau, Skalski, and Townsend 2005). The 12 spillway gates and

sluiceway at Wanapum Dam are designed to pass up to 1,400 kcfs, while the WFB is designed to pass an additional 20 kcfs. There are also fish-ladders on the right and left banks of Wanapum Dam, which pass up to two kcfs depending on forebay elevations.

Water is passed through Priest Rapids Dam either through the ten powerhouse units, 19 spillways, and/or the PRFB (Figure 3 and Figure 6). Maximum flow through each powerhouse unit ranges from 15-18 kcfs, passing 135–162 kcfs of total flow assuming 90% capacity (e.g. one unit out of operation), depending on forebay and tailwater elevations, power market conditions, and presence of out-migrating salmonids. During the fish-spill season, the turbines at Priest Rapids Dam are limited to 17.4 kcfs in order to provide optimal passage conditions for migrating salmonids based on turbine survival studies conducted at Priest Rapids Dam (Normandeau and Skalski 2005). The 19 spillway gates at Priest Rapids Dam are designed to pass up to 1,210 kcfs, while the PRFB is designed to pass an additional 22 kcfs. There are also fish-ladders on the right and left banks of Priest Rapids Dam, which pass up to two kcfs depending on forebay elevation.

1.3.3 Fish-Spill

Prior to 2005, Grant PUD's fish-spill programs were based on a Memorandum of Agreement (MOA) that called for Wanapum Dam to spill up to forty-three percent of total river flows during the spring season (from mid-April to mid-June) and forty-nine percent during summer (mid-June to mid-August). As a practical matter, TDG levels typically limited Wanapum spill to thirty-three to thirty-eight percent. Priest Rapids Dam was required to spill sixty-one percent of total river flow during the spring season (from mid-April to mid-June) and thirty-nine percent during summer (mid-June to mid-August). Again, these spill levels were typically adjusted in an effort to remain below TDG water quality standards.

On April 1, 2005, the PRCC gave concurrence to Grant PUD to implement alternative spill measures at Wanapum Dam as identified in RPA 6 of the 2004 Biological Opinion for the Project (NMFS 2004). These alternative spill methods were based on route-specific fish passage survival studies (Robichaud et al. 2005) which suggested that top-spill, powerhouse, and sluiceway passage were preferred for juvenile passage survival over passage via Wanapum spillway, and to support TDG levels within water quality criteria. Therefore, with the concurrence of the PRCC, Grant PUD moved from a tainter-gate spring fish-spill (Wanapum MOA spill) program to a "Gate 12 top-spill and sluiceway only" spill program during the 2005 fish-spill season. The PRCC also instructed Grant PUD to proceed with the spill program outlined in RPA 16 of the 2004 Biological Opinion (NMFS 2004) for Priest Rapids Dam in 2005, which is sixty-one percent of average daily total river flow, subject to TDG levels being below water quality standards, for spring migrants.

On February 1, 2008, NMFS issued a subsequent Biological Opinion (NMFS 2008) for the Project related to the FERC operating license (FERC 2008). The Biological Opinion incorporated the conditions of the 2004 Biological Opinion as they relate to Grant PUD's fish-spill program, and those terms and conditions were incorporated in the FERC license to operate the Project (FERC 2008). RPA 1, and associated terms and conditions of the Biological Opinion require Grant PUD to initiate its fish-spill programs before 2.5 percent of the spring migration period has passed, as documented by smolt index counts at Rock Island Dam. The spring fish-spill program can conclude when 97.5 percent of the spring migration period is complete, or on June 15, whichever occurs first. The summer fish-spill program begins immediately after the end of the spring fish-spill season and is guided by the PRCC and the fishway prescriptions set forth

in the 2006 Priest Rapids Project Salmon and Steelhead Settlement Agreement (Grant PUD 2006) and shall continue until 95 percent of summer outmigrating fish have passed. Grant PUD also provides limited spill (typically around two kcfs) for adult fallback from the end of the fish-spill season until November 15, annually.

The 2004 through 2016 TDG-fish-spill summary reports submitted to WDOE (Hendrick 2004 – 2008, 2009b, and Keeler 2010-2016) provide greater detail on the amounts and duration of fish-spill.

1.3.4 Other Types of Spill

The following sections provide a brief summary of the other types of spill that can occur at a mid-Columbia River hydroelectric development.

1.3.4.1 Flow in Excess of Hydraulic Capacity

The limited storage and hydraulic capacity of a given project may occasionally require forced or involuntary spill 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 dam, 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, Grant PUD attempts to implement pre-emptive spill so that small amounts of spill can occur if upstream flow predictions were anticipated to be higher than predicted power-load demand, which would lead to involuntary spill. Pre-emptive spill can be initiated several hours prior to the high flows, thus making room to store the excess water until it can be passed through the turbines (e.g. when power-load demand increases). This reduces the need to involuntarily spill larger amounts of water through the tainter-gates, which typically leads to higher TDG levels. The lower, longer sustained, pre-emptive spill typically does not lead to TDG levels in excess of TDG water quality standards. Pre-emptive spill events require close coordination with upstream project operators through Grant PUD's Power Marketing, dam Operators, and Environmental Affairs departments.

1.3.4.2 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 turbine units off line. This is an emergency situation and generally requires emergency involuntary spill. When the units cannot process flow, the flow must be passed by other means to avoid overtopping the dam.

1.3.4.3 Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillbays and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. Section 2.1 provides information related to minimizing involuntary spill by scheduling maintenance operations, to the extent practicable, based on predicted flows. This will include limiting turbine maintenance during high flow and power load periods to emergency maintenance only, if possible. Any required spillgate maintenance that may necessitate spill will be coordinated in a manner that has the least effect on TDG.

1.3.4.4 Error in Communication Spill

Error in communication with the U.S. Army Corps of Engineers (Corps) Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to involuntary spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

1.3.5 Total Dissolved Gas

The summation of the partial pressures of the individual gases in solution – primarily N_2, O_2, and CO_2 is known as TDG. As water is spilled into the tailrace air becomes entrained. This air/water mixture is then forced to the bottom of the stilling basin and the increased hydrostatic pressure forces the air into solution. The result is that water becomes supersaturated with those gases normally found in the atmosphere.

Continuous TDG has been measured within the Project since 1995. Early data collection at Grant PUD's fixed-site monitoring stations (FSM stations) focused mainly on the fish-spill season, but data is now collected hourly year-round. Intensive near-field work at Wanapum and Priest Rapids dams has also been completed to evaluate the effects of system operations (Corps 2001, 2003). Additionally, vertical TDG profiles were completed at mid-channel and near the shorelines during the 1999 synoptic study (Normandeau et al. 2000). Both Juul (2003) and Normandeau et al. (2000) provide extensive background information on TDG levels within the Project prior to 2003. Since 2004, Grant PUD has been providing WDOE with summary reports of TDG monitoring during the fish-spill season (Hendrick 2004 – 2008, 2009b, Keeler 2010-2016). These reports are mainly focused on TDG levels measured at the FSM stations during the fish-spill season. Grant PUD also provided WDOE with an annual water quality monitoring report, which covers TDG monitoring results during the non-fish spill season (Keeler 2010b-2016b). In general, TDG levels are greatest during the spring fish-spill season (April-June), especially during years when incoming flow volumes exceed Wanapum Dam's hydraulic capacity (~161 kcfs), plus the WFB (~22 kcfs, for a total hydraulic capacity of ~183 kcfs).

The web link to the 2017 TDG/fish-spill summary report (Keeler 2017) will be included in this GAP as Appendix A on page A-1. This web link will be active on, or before October 31, 2017.

2.0 Proposed Operational Total Dissolved Gas Abatement Measures

The following sections describe operational TDG abatement measures proposed for implementation to help abate TDG levels.

2.1 Minimizing Involuntary Spill

Section 6.4.1(c) of the 401 WQC (WDOE 2007) requires Grant PUD to minimize involuntary spill, as reasonable and feasible, at Wanapum and Priest Rapids dams in order to meet TDG water quality standards. This includes:

- Minimizing involuntary spill by scheduling maintenance operations, to the extent practicable, based on predicted flows. This will include limiting turbine maintenance during high flow and power load periods to emergency maintenance only, if possible. Any required spillgate maintenance that may necessitate spill will be coordinated in a manner that has the least effect on TDG.

- Minimizing involuntary spill by continuing to participate in cooperation and coordination with other Mid-Columbia operators and/or through other agreements or arrangements.
- Attempting to maximize powerhouse discharge during periods of high flows.

Additional operational measures that will be implemented, when feasible, to minimize involuntary spill and the TDG impacts associated with involuntary spill include:

- Attempting to maximize turbine flows by setting minimum generation requirements, this includes establishing a common methodology for setting minimum generation requirements specific to Wanapum and Priest Rapids dams for the management of TDG. Mandating a high level of turbine usage during periods of high flow is a potentially effective means of limiting involuntary spill and TDG impacts; however, during periods of very high-sustained flows, there is not adequate turbine capacity to sufficiently limit spill.
- Participation in regional spill/project operation meetings. These meetings often occur prior to and during the fish spill season and include representatives from Environmental Affairs, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Association (BPA) and the Corps. Discussions would likely include topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resource requirements (e.g. Hanford Reach fall Chinook flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.
- Preemptive spill can be used to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. The spill rate could be stabilized if a project's storage was used to absorb flow fluctuations from upstream projects. Generally, a target operation of one foot from the allowed maximum at each project could be used. When flows spike high, the storage could be used to lower the need for spill; when flows drop, the storage quantities could be reestablished by maintaining spill rates. Allowing a greater amount of storage to absorb variations can be an effective method in stabilizing spill flows but it can also provide adequate time for adjusting spill to meet survival study objectives and TDG requirements

2.2 Operational Changes

Per condition 6.4.1(e) of the 401 WQC (WDOE 2007), Grant PUD will provide WDOE with an opportunity to review and condition any non-routine operational change that may affect TDG which is not identified in the 401 WQC. General fishway, spillway, and turbine operation/maintenance schedules and timelines are described in the Fisheries Operation Plan (see Section 2.4).

2.3 Fish Spill

During the 2018 fish-spill season, Grant PUD intends to implement spill programs at Wanapum and Priest Rapids dams as guided by the Biological Opinion (NMFS 2008) and the PRCC, which are proposed to be the same as was done in 2017. Grant PUD's fish-spill program is intended to help meet the biological objectives as defined in section 6.2.3 of the 401 WQC (WDOE 2007). The biological objectives represent important steps toward meeting the designated uses of a water body. They serve as quantifiable goals for moving toward attaining full support of designated uses, and are not intended to serve as a surrogate for the requirement to support and project designated uses of the water body. Biological objectives for Endangered Species Act (ESA) covered fish species are outlined in the Biological Opinion (NMFS 2008) and the Priest Rapids Project Salmon and Steelhead Settlement Agreement (Grant PUD 2006), while biological objectives for non-ESA covered fish species are described in the 401 WQC (WDOE 2007).

Final approval of the 2018 fish-spill season programs will be obtained from the PRCC in the spring of 2018, prior to the start of the 2018 fish-spill season. In general, fish-spill levels will be modified as needed to remain in compliance with TDG water quality standards, in consultation with the PRCC. WDOE will be given at least 48 hours of notification prior to the beginning of the fish-spill season.

2.3.1 Wanapum Dam

The primary fish-passage route at Wanapum Dam in 2018 will be the WFB, which passes up to 20 kcfs depending on forebay and tailwater elevations, and turbine passage. Results from various fish survival/behavior studies indicate that survival through the WFB is greater than 95% (Skalski et al. 2009, Timko et al. 2009, Skalski et al. 2010) and therefore the WFB was approved by the PRCC as the primary fish passage at Wanapum Dam. Results from the 2008 WFB TDG study indicate that the operation of the WFB does not negatively affect TDG levels (Hendrick et al. 2009); results from the 2009 – 2016 fish-spill season also indicate no negative impacts to TDG levels during operation of the WFB (Hendrick 2009b, Keeler 2010-16).

2.3.2 Priest Rapids Dam

The primary fish-passage route at Priest Rapids Dam in 2018 will be the PRFB, which passes up to 22 kcfs depending on forebay and tailwater elevations, and turbine passage. Results from various fish survival/behavior studies indicate that survival through the PRFB is greater than 95% (Hatch et al. 2015, Skalski et. al 2016) and therefore the PRFB was approved by the PRCC as the primary fish passage at Priest Rapids Dam. Results from the 2014 PRFB TDG study indicate that the operation of the PRFB does not negatively affect TDG levels (Keeler 2015); results from the 2009 – 2016 fish-spill season also indicate no negative impacts to TDG levels during operation of the WFB (Hendrick 2009b, Keeler 2010-16).

2.4 Fishery Operation/Management Plan

Grant PUD's Fishery Operations Plan describes the fisheries-related operating criteria, protocols, and annual schedule of operation and inspection for the Project turbines, WFB, spillways, sluiceways, fishways, and off-ladder adult fish trapping facility. In previous GAPs, The Fishery Operations Plan was included as Appendix B; however, on May 1, 2012, Grant PUD filed a request with FERC to modify the filing protocol and deadlines for the Downstream Passage Alternatives Action Plan (401(a)(1)), Progress and Implementation Plan (401(a)(2)), Habitat Plan (401(a)(3)), Artificial Propagation, Hatchery and Genetic Management, and Monitoring and

Evaluation annual reports (401(a)(4)), Priest Rapids Dam Alternative Spill Measures Evaluation Plan (401(a)(8)), and the annual Fishery Operations Plan (Article 404). FERC issued an Order modifying the filing protocol and deadlines on June 15, 2012, in which all above mentioned annual reports are to be combined into a single report, with a new annual reporting date of April 15. Because April 15th is beyond the February 1st GAP completion date as required by Section 6.4.11(e) of the 401 WQC (WDOE 2007), Grant PUD will provide WDOE with a copy of the combined report, which will include a description of Grant PUD's fishery operations plan, if requested, on or before April 15, 2018.

2.5 Biological Monitoring

Grant PUD's biological monitoring program to date, as it has related to its GAP, has included specific gas bubble trauma monitoring (GBT) consistent with the Biological Opinion(s) for the Project (NMFS 2004, 2008), which included the collection and monitoring of at least 100 salmonid and/or steelhead smolts twice a week from various gatewells at Priest Rapids Dam for signs of GBT. Smolts were collected for inspection via Grant PUD's gatewell dipping operations at both dams as part of a gatewell smolt salvage operations for the duration of the salmonid smolt out-migration each year. In 2012, the PRCC approved a statement of agreement (SOA) 2011-10, stating that (salvage) gatewell dipping at Wanapum Dam was no longer required because of the success of passage through the WFB and that once the PRFB was placed in operation, (salvage) gatewell dipping would no longer be required at Priest Rapids Dam. Both the Wanapum and Priest Rapids fish bypass structures have been completed and are operational, and thus gatewell smolt salvage operations have ceased; thus eliminated Grant PUD's current method for collecting smolts for GBT analysis. On May 12, 2016, Grant PUD submitted to the PRCC a proposal to discontinue monitoring smolts for GBT within the Project that was based on eight years (2008-2015) of data collection in which showed less than 0.3% of smolts examined were shown to have been seriously impacted by gas bubbles. The PRCC agreed that suspending the use of GBT monitoring within the Project until further notice was acceptable.

Although the PRCC agreed that Grant PUD can suspend its GBT monitoring program until further notice, to be consistent with Grant PUD's obligations under the 401 WQC and WAC 173-201A(1)(f)(ii), Grant PUD will continue to implement a biological monitoring plan associated with this GAP during the fish-spill season. However, because Grant PUD's current method of collecting smolts for GBT examination is no longer available on an annual basis, and based on the results of the last nine years of GBT monitoring, which has shown less than 2% of the total fish examined exhibited signs of GBT, and of those less than 0.2% had a rank higher than 1, Grant PUD is proposing an updated biological monitoring program as part of this GAP. Collecting and handling up to 200 ESA-listed spring Chinook salmon and steelhead for the purposes of GBT monitoring, on a weekly basis each year during the fish-spill season (April through August) is no longer necessary given the results of the previous nine-years of data. Instead, a modified GBT monitoring schedule is proposed that will allow for continued protection of the fish, including reduced handling. This updated biological monitoring program will include two components:

1). Conduct GBT monitoring in accordance with Grant PUD's future survival studies, during which gatewell operations will be conducted that will provide a source of fish for examination. Grant PUD is currently scheduled to conduct fish survival evaluations for each anadromous fish species every 5 years, and its next studies are scheduled to occur in 2019 (for Yearling Chinook) and 2020 (for Sockeye). During these studies, Grant PUD

will examine up to 100 Chinook/Steelhead smolts for signs of GBT once every two weeks during the fish-spill season (~April through August).

2). Monitor the results of weekly GBT analyses from the next upstream project, Rock Island Dam, which conducts specific and regular GBT monitoring of up to 200 smolts per week in conjunction with the Fish Passage Center (FPC) at the Rock Island Bypass Trap. Results of these analyses are posted to the FPC web-site (FPC 2017). If TDG levels in the mid-Colombia River are elevated above 125% for extended periods (e.g. over four consecutive weeks), and if GBT monitoring data from Rock Island Dam shows GBT in more than 5 fish with signs above a ranking of 2, Grant PUD will immediately consult with Ecology on possible next steps related to more specific GBT monitoring within Grant PUD's Project.

Grant PUD will continue to update this biological monitoring plan with each annual update to this GAP and adaptively manage its GBT monitoring plan as needed based on updated information and/or literature, TDG data, and upstream GBT data.

2.6 Participation in Water Quality Forums

As part of this 2018 GAP, Grant PUD will continue its participation in regional water quality related forums, including the Corps' end-of-year TDG monitoring summary meetings and other forums as applicable to TDG abatement issues. Grant PUD staff will also attend applicable trainings and/or workshops related to TDG abatement and/or monitoring methods.

3.0 Proposed Structural Total Dissolved Gas Abatement Measures

The following sections provide a summary of the structural TDG abatement measures installed to date as part of this GAP.

3.1 Wanapum Dam Spillway Deflectors

To address elevated TDG levels caused by spill, Grant PUD worked from 1996 through 2000 to develop spillway flow deflectors at Wanapum Dam. The objective of the flow deflectors is to produce a skimming flow across the water surface instead of allowing spill to plunge. After testing several designs in consultation with the agencies, tribes, and stakeholders, FERC approved construction of a full set of twelve flow deflectors (one for each spillbay) on November 15, 1999. Construction was completed in time for the 2000 fish-spill operations.

Juul (2003) and the Corps (Corps 2001) evaluated relationships between spill levels and TDG for pre- and post-deflector time periods at Wanapum Dam. Prior to the installation of the flow deflectors, gas saturation increased non-linearly with spill. After the deflectors were installed, TDG levels were reduced by as much as 10%.

While the Wanapum Dam flow deflectors appear to be effective at reducing TDG, there may be issues related to fish passage that created concern about fish passage survival. Although tests of direct mortality showed little injury to smolts, more recent evaluations suggest that skimming surface flow and edge effects associated with spill across the deflectors may expose smolts to bird predation that appears to result in lower survival rates than for smolts passing through the turbines (Robichaud et al. 2003). These evaluations led, in part; to the development of alternative fish-passage measures at Wanapum Dam.

3.2 Wanapum Fish Bypass

The Wanapum Fish Bypass (WFB) was completed in 2008 and was fully operational during the 2008 fish-spill season (Figure 5). Results from various fish survival/behavior studies indicate that survival through the WFB is greater than 95% (Skalski et al. 2009, Timko et al. 2009, Skalski et al. 2010) and therefore the WFB was approved by the PRCC as the primary fish passage at Wanapum Dam. Additionally, results from the TDG evaluation associated with the operation of the WFB showed no negative impacts to TDG uptake (Hendrick et. all 2009).

Figure 5 Wanapum Fish Bypass facility, mid-Columbia River, WA.

3.3 Wanapum Dam Advanced Turbines

Grant PUD completed installation of the tenth Advanced Hydro Turbine System at Wanapum Dam in September of 2013. Additionally, in accordance with the terms and conditions contained in the 401 WQC (WDOE 2007) Grant PUD conducted a TDG evaluation with all 10 advanced turbines in operation in October of 2013 in accordance with the Wanapum Dam Advanced Turbine Total Dissolved Gas Evaluation (see Keeler 2012c for more details), to determine the impact, if any, the operation has on TDG. Results from these evaluations are presented in Keeler 2014 and were submitted to the WDOE/PRCC and the FERC on December 13, 2013 and February 20, 2014, respectively. In summary, operation of all 10 units does not negatively impact TDG production.

3.4 Priest Rapids Fish Bypass

The Priest Rapids Fish Bypass (PRFB) was completed in April of 2014 and was operated as the primary means of outmigration during the 2014 fish-spill season (Figure 6). The PRFB was constructed to safely pass juvenile salmonids during their outmigration and to comply with TDG

water quality standards. In accordance with the terms and conditions contained in the Project's 401 water quality certificate (WQC; WDOE 2007), Grant PUD conducted TDG evaluations during the first part of August 2014 (see Hendrick and Keeler 2011 for more details) to determine any potential TDG impacts. The final evaluation was submitted to both the WDOE and FERC on March 29, 2016 showing no negative impacts to TDG from operation of the PRFB (Keeler 2016).

Figure 6 Priest Rapids Fish Bypass facility, mid-Columbia River, WA.

4.0 Compliance/Physical Monitoring

The following sections describe Grant PUD's TDG compliance monitoring program, and includes information about its fixed-site monitoring program and Quality Assurance Protection Plan (QAPP, Hendrick 2009c; Appendix B).

4.1 Fixed-Site Monitoring Stations

Grant PUD currently operates and maintains four fixed-site water quality monitoring stations (FSM stations) that record water depth (m), barometric pressure (millimeters of mercury (mm Hg)), TDG (mm Hg), temperature (°C), dissolved oxygen (DO; milligrams per liter (mg/L)), pH (units), and turbidity (Nephelometric Turbidity Unit (NTU)). Barometric pressure, TDG, and temperature are monitored on an hourly basis throughout the year, while depth, DO, pH, and turbidity are monitored on a bi-weekly basis throughout the year (Hendrick 2009c; Appendix B). Each FSM station is equipped with a HydroLab® Corporation Model DS5X®, DS5A®, DS4A®, or Minisonde® multi-probe enclosed in a submerged conduit. Multi-probes are connected to an automated system that allows Grant PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. A National Institute of Standards and Technology (NIST)

certified barometer located at each FSM station provides the barometric pressure readings necessary to correct the partial pressure readings taken by the HydroLab® multi-probes.

Grant PUD FSM stations are located midway across the river channel in the forebay and tailrace of each dam (see Figure 7 and Figure 8). The Wanapum Dam forebay FSM station is located near Turbine Unit 10 and is affixed to a catwalk approximately mid-channel. The Wanapum Dam tailrace FSM station is located approximately 3.2 RM downstream of Wanapum Dam. The tailrace standpipe is located at mid-channel and is attached to the downstream side of Beverly Bridge. The FSM station in the forebay of Priest Rapids Dam is attached to the pier nose directly between the powerhouse and the PRFB and is located at mid-channel at approximately the center of the dam. The Priest Rapids Dam tailrace FSM station is located nine miles downstream of Priest Rapids Dam affixed to Vernita Bridge. The Pasco FSM station located at RM 329 and owned/operated by the Corps, serves as the next downstream forebay TDG compliance point for Priest Rapids Dam. This location was chosen to measure mixed river gas conditions before dilution or concentration with the waters of the Snake River. Chelan PUD also operates and monitors a FSM station located in the Rock Island Dam tailrace, approximately 38 RM upstream of Wanapum Dam, during the fish-spill season. This FSM station, along with other upstream FSM stations, allows Grant PUD to monitor upstream river conditions.

Section 6.4.10(a) of the 401 WQC (WDOE 2007) required Grant PUD to either move the TDG tailrace compliance locations to within 2,000 feet of Wanapum Dam and 1,500 feet of Priest Rapids Dam, or provide WDOE with a method and schedule for establishing new FSM stations, with indexing to the current FSM stations as needed. A Total Dissolved Gas Compliance Monitoring Location report (Grant PUD 2010) was sent to WDOE on April 16, 2010 for approval. WDOE approved the report on July 15, 2010 to use the current FSM locations during non-fish passage periods (WDOE 2010).

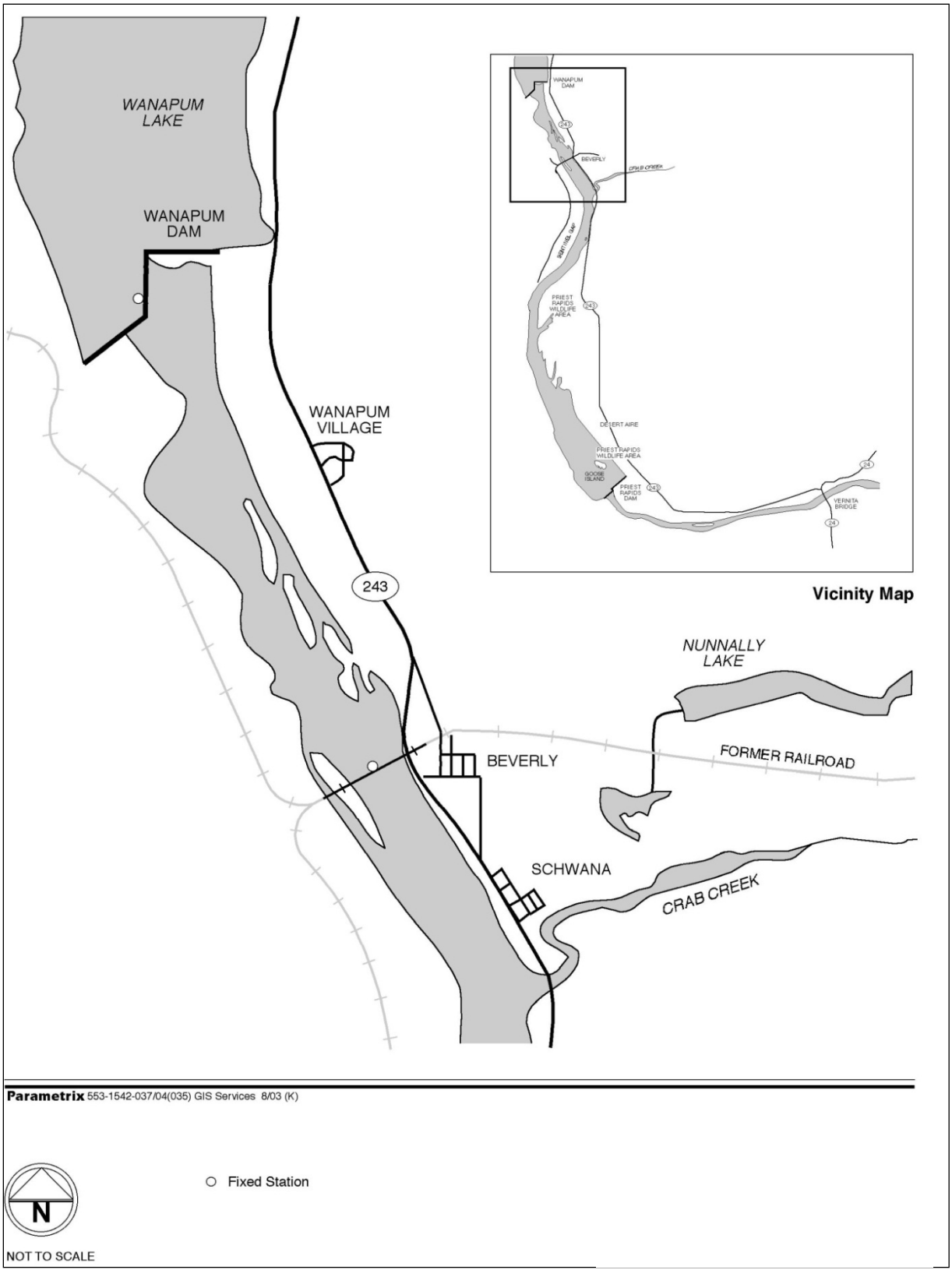

Figure 7 Location of water quality fixed-site monitoring stations for Wanapum Dam.

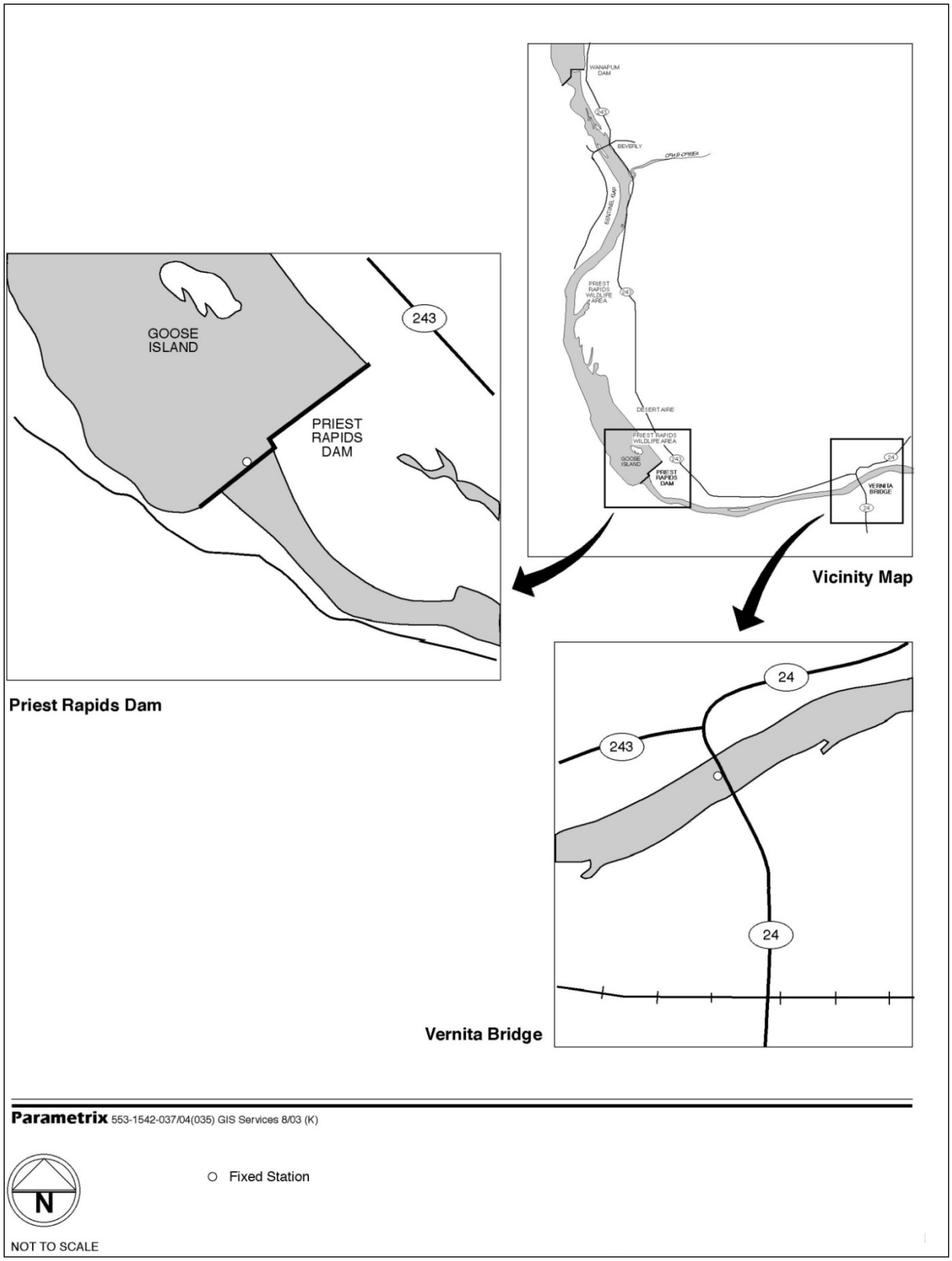

Figure 8 Location of water quality fixed-site monitoring stations for Priest Rapids Dam.

4.2 Quality Assurance Project Plan

Section 6.4.10(c) of the 401 WQC (WDOE 2007) requires Grant PUD to maintain a TDG quality assurance/quality control (QA/QC) program that is at least as stringent as QA/QC procedures developed by the USGS. In 2003, Grant PUD developed its QA/QC protocols following established protocols by HydroLab® Corporation, the USGS, and the Corps (Duvall and Dresser 2003). These QA/QC protocols have been updated in Grant PUD's FSM QAPP (Hendrick 2009c), per section 6.7.1 of the 401 WQC (WDOE 2007). The QAPP is included in this 2018 draft GAP as Appendix B.

4.3 Compliance Reporting

The following sections discuss Grant PUD's TDG reporting requirements, including reporting TDG data to its water quality web-site, notification of the start of the fish-spill season, and content of the TDG annual report.

4.3.1 Water Quality Web-Site

Hourly, daily summary, and monthly summary TDG and water temperature data recorded at each of Grant PUD's FSM stations, along with corresponding total river flow and spill volumes at each dam, are posted to Grant PUD's Fixed Site Water Quality Monitoring web-site, located at:

http://www.grantpud.org/index.php/environment/water-quality/monitoring-data

The following data is available at this web-site:

- Fixed-Site Monitoring - Hourly Data: Provides daily ".xls" and ".csv" files showing data that has received QA/QC review and verification; includes calculation of twenty-four hour averages and average of the twelve highest consecutive hourly TDG values. Hourly and mean daily total river flow, spill, and spill percentages from each dam are also included.
- Fixed-Site Monitoring - Monthly Summary: A ".xls" file that provides daily mean values for TDG, water temperature, and flow/spill separated by month.
- 72-Hour Water Quality Information: Previous seventy-two hours (~two hour delay) of TDG, water temperature, and flow/spill data that is considered preliminary, has not received final QA/QC review and verification, and is subject to change based on QA/QC review.

Data from previous years can also be accessed from the water quality web-site.

4.3.2 Notifications

Grant PUD shall notify WDOE within 48 hours of the beginning of the fish-spill season, per section 6.4.11 (b) of the 401 WQC (WDOE 2007).

4.3.3 Annual Report

Per section 6.4.11 of the 401 WQC (WDOE 2007), Grant PUD provides WDOE with an annual TDG monitoring report by October 31 of each year. The TDG monitoring report will potentially include as feasible:

- flow and runoff descriptions for the fish-spill season;

- spill quantities and duration;
- quantities of water spilled for fish versus spill for other reasons for each development (Wanapum and Priest Rapids dams);
- data from the physical and biological monitoring programs, including:
    - a summary of TDG water quality exceedances,
    - causes of the exceedances, and
    - a description of what was done to correct the exceedance;
- monitoring and compliance for fish passage efficiency and survival under the Priest Rapids Project Salmon and Steelhead Settlement Agreement (Grant PUD 2006) and as otherwise required for non-Covered Species under the 401 WQC (WDOE 2007). Due to the complexity of the fish passage and survival studies and proper evaluation of study data, the final results were not available at the time the annual TDG report was developed. Note that Section 6.1.7 of the 401 WQC (WDOE 2007) provides WDOE the right to modify schedules and deadlines required by the 401 WQC.

The web link to the 2017 TDG monitoring report is included in Appendix A of this GAP.

5.0 Conclusions

As described in this draft 2018 GAP, Grant PUD has implemented structural TDG abatement measures to help abate TDG levels, and plans to continue to implement operational TDG abatement measures in 2018. This 2018 draft GAP will be updated annually to reflect any changes to implementation schedules, new or improved technologies, or TDG abatement measures.

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Appendix A
Summary of 2017 Fish-Spill Season and Total Dissolved Gas Monitoring

The 2017 Fish-Spill Season and Total Dissolved Gas Monitoring Report can be found at the following URL on or before October 31, 2017:

http://www.grantpud.org/index.php/environment/water-quality/monitoring-data

Appendix B
Quality Assurance Project Plan

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

http://www.grantpud.org/index.php/environment/water-quality/monitoring-data