Wells Hydroelectric Project
Total Dissolved Gas Abatement Plan

2012 Annual Report

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1 INTRODUCTION

The 2012 Wells Hydroelectric Project Gas Abatement Plan (GAP) was approved by the Washington State Department of Ecology (Ecology) on April 6, 2012 (Appendix 1 and Appendix 2). The GAP and its associated measures are intended to meet state water quality standards for total dissolved gas (TDG). This annual report concludes the 2012 monitoring season and describes the background, operations, and results of GAP implementation at the Wells Hydroelectric Project (Wells Project) in 2012.

1.1 Project Description

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

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. The hydrocombine is 1,130 feet long, 168 feet wide and has a top of dam elevation of 795 feet above mean sea level (msl). Upstream fish passage facilities are located on both sides of the hydrocombine.

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

1.2 Fixed Monitoring Site Locations

Fixed monitoring stations for TDG are located above and below Wells Dam. The forebay station (WEL) is located midway across the deck of Wells Dam (47° 56’ 50.28” N, 119° 51’ 54.78” W). The tailrace station (WELW) is located on the left bank of the Columbia River 2.6 miles downstream of Wells Dam (47° 54’ 46.86” N, 119° 53’ 45.66” W). Hach® HYDROLAB MiniSonde instruments equipped with TDG and temperature probes are deployed approximately 15 feet below normal surface water elevation and are calibrated monthly (example in Appendix 3). Data from both stations are automatically transmitted by radio to Wells Dam, stored, and forwarded to the USACE. Weather data are recorded by Global Water, Inc. instrumentation, including an electronic barometer located on the deck of Wells Dam at 810 feet elevation.

Figure 1. Location of the Wells Project.

1.3 Regulatory Framework

Washington Administrative Code (WAC) Chapter 173-201A identifies the Water Quality Standards (WQS) for surface waters in Washington State. The WQS state that TDG measurements shall not exceed 110% saturation at any point of measurement in any state water body. The WQS provide for two exceptions to this rule: (1) during natural flood flows, and (2) for spill over dams to increase survival of downstream migrating juvenile salmon.

Natural flood flows are identified by periods in which river flow volume exceeds the highest seven consecutive day average observed during a ten-year period, called the 7Q-10 flow. The 7Q-10 flow for the Wells Project is 246,000 cubic feet per second (cfs), based on the hydrologic records from 1930 to 1998 and the USGS Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (Pickett et al. 2004). When river flow volume exceeds 7Q-10 flows, the WQS permits exceedances of the 110% TDG saturation standard.

Ecology may also approve an exception to the 110% upper criterion for TDG saturation during the outmigration of juvenile salmon; provided that spill aids in the survival of fish. The TDG exception is considered by Ecology on a per-application basis and must be accompanied by an approved GAP (WAC 173-201A-200(1) (f) (ii)). On the Columbia and Snake rivers, the TDG exception for fish passage has three standards during the fish passage (spill) season: (1) TDG shall not exceed 125% saturation in the tailrace of the project as measured in any one-hour period; (2) TDG shall not exceed 120% saturation in the tailrace of the project based on the average of the twelve highest consecutive hourly readings in any

one day (12C-High[1]); and, (3) TDG shall not exceed 115% saturation in the forebay of the next downstream project based on the average of the twelve highest consecutive hourly readings in any one day.

1.4 2012 Gas Abatement Plan Approach

1.4.1 Operational

Based on the success of 2009 and 2010 operations associated with implementation of the Wells Project Spill Playbook (Spill Playbook), those operations were implemented again in 2011 and 2012 with minor modification as described below.

In February 2011, Douglas PUD conducted an additional technical analysis of the 2010 Spill Playbook (after in-season changes) and confirmed that continued implementation would be appropriate for 2011 with additional minor modifications. Additional recommendations for 2011 and 2012 operations, from a TDG management perspective, included:

1. Minimize spill.
2. Forced Spill (≤ 53.0 kcfs). Switch the priority for forced spill less than 53.0 kcfs from spillbay 7 to spillbay 5. Units 4 and 5 should be operated to support spill from spillbay 5.
3. If spill exceeds 53.0 kcfs, or is predicted to exceed 40.0 kcfs for more than 8 hours, remove the Juvenile Bypass System (JBS) barriers in spillbay 6.
4. When spill exceeds 30.0 kcfs in spillbay 5 and JBS barriers have been removed in spillbay 6, shift at least 15.0 kcfs from spillbay 5 to spillbay 6 (i.e., 27.2 kcfs and 15.0 kcfs through spillbays 5 and 6, respectively). Support spill through spillbays 5 and 6 by operating units 4, 5 and 6.
5. Reinstall the JBS barriers if total spill is predicted to remain below 40.0 kcfs for more than four days.

Modifications were based on previous adaptive operational results, model predictions, and operational contingencies for unplanned unit outages.

Despite operational and environmental challenges during the 2011 spill season, when Wells Project flows were below the 7Q-10 flood flows (246 kcfs) and forebay TDG levels were less than 115%, Douglas PUD had very high compliance values for all three standards. Based on this high compliance rate under challenging conditions, the 2012 Gas Abatement Plan and Spill Playbook contained few additional measures when compared to the 2011 Gas Abatement Plan and Spill Playbook. The 2012 Spill Playbook is attached as Appendix 4.

[1] Ecology currently uses the methodology described in Appendix 5 for determining 12C-High TDG values in the tailrace and forebay of Columbia Basin hydroelectric projects.

During the 2012 flood flow periods, the Wells Project was an 8 unit plant. This is highly unusual for Wells Dam and was largely attributed to our turbine contractors' inability to properly reassemble the turbine in Unit 7. In addition to this prolonged unit outage, an unplanned mechanical breakdown of unit 6 also took place during the peak of the spring runoff. Further, bi-annual maintenance occurred during May and August when flows typically accommodate this maintenance. However, during 2012, high flows occurred even in the months of May and August when units 1, 2 and 3 were serviced. During these service and breakdown periods Wells Dam had a generating hydraulic capacity of approximately 160 kcfs (versus 180 kcfs for a 9 unit plant).

1.4.2 Structural

No permanent structural modifications were proposed or conducted in the 2012 monitoring season.

1.4.3 Consultation

Douglas PUD will continue to direct all correspondence related to compliance with the TDG standards to the Hydropower Projects Manager, Department of Ecology, Central Region Office, Water Quality Program, 15 W. Yakima Avenue, Suite 200, Yakima, Washington 98902.

2 OPERATIONS

2.1 Description of Fish-Spill Season Flow

The 2012 Fish Spill Season occurred April 9th (0:00 hrs) through August 19th (12:00 hrs) at Wells Dam. As required, TDG data were monitored during this period and transmitted to the USACE, Northwest Division on a real-time basis (www.nwd-wc.usace.army.mil). Historical data is also available for download at this website. Data from 1969 to 2011 (42 years) show that average monthly flows between April and August range from 51.9 to 348.7 kcfs at the Wells Project. During this time period, flows tend to be highest in June (mean 164.5 kcfs), and lowest in August (104.6, Table 1). Flows at the run-of-river Wells Project are determined by upstream storage releases at the Grand Coulee Hydroelectric Project, with less than 5% of the flow provided by tributaries flowing into the Wells Project.

Table 1. Monthly total river discharge (kcfs) from the Wells Project (April-August), 1969-2011.

Month	April	May	June	July	August
Mean Monthly Average (kcfs)	115.6	149.4	164.5	132.2	104.6
Minimum Monthly Average (kcfs)	51.9	55.2	73.7	53.4	63.9
Maximum Monthly Average (kcfs)	184.9	262.6	348.7	221.9	181.3

Columbia River flows at Wells Dam in 2012 were the 3rd-highest on record for the months of April through August (next to 1972 and 1997). Over 42-year historical record, only 1972 (218.8 kcfs) and 1997 (207.7 kcfs) had higher average monthly flows than the 2012 spill season (207.3 kcfs). Average monthly river flow at the Wells Project was 41.6-92.0% higher than the 42-year average for the April through August fish spill season (Figure 2). The average flow during the 2012 fish spill season was 56% (74 kcfs) higher than the previous 42-year average (Table 2). Flows for all months during the spill season were higher than the monthly 42-year average. The maximum hourly flow observed during the spill season was 314.2 kcfs on June 25 and flows frequently exceeded the 7Q-10 value of 246.0 kcfs by 68 kcfs. The average monthly flow for all of July was 253.8 kcfs. This value also exceeded the 7Q-10 value for the Wells Project. Of the 133 days during the Wells fish spill season, there were 56 days (42% of the monitoring period) where one or more hourly values were above 7Q-10 flows at the Wells Project, including a 38-day uninterrupted stretch from June 19 to July 26th.

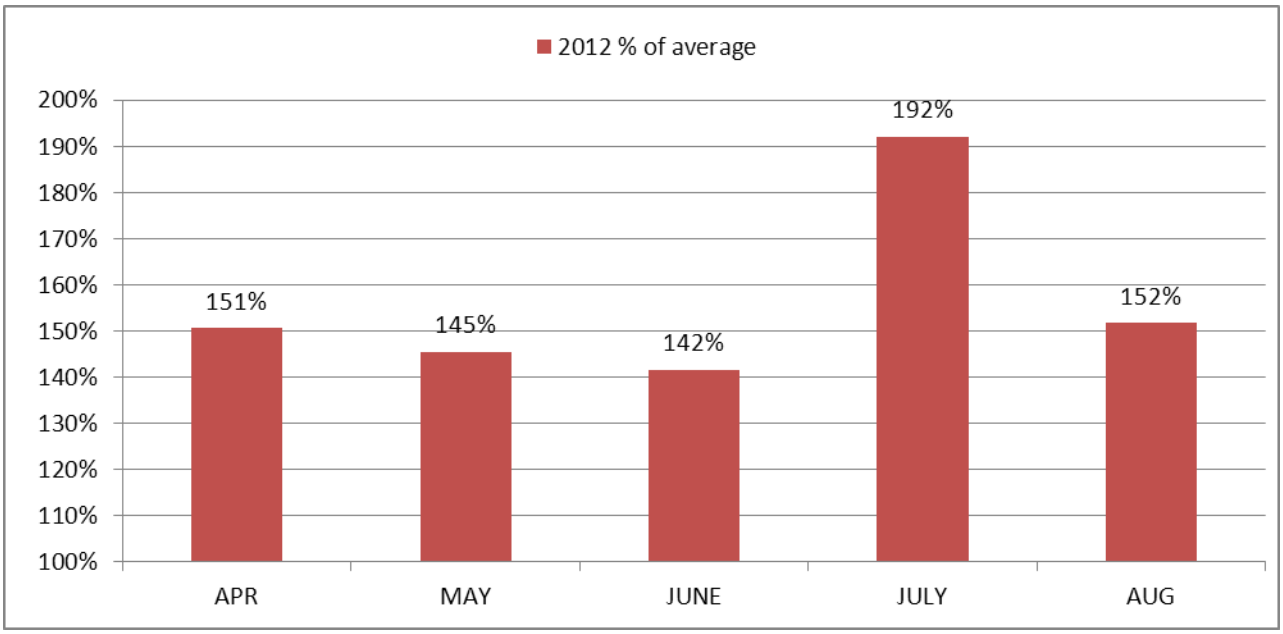

Figure 2. **Increase in 2012 flows compared to average monthly flows (1969-2011) during the fish spill season, where 100% would be average montly volume.**

Table 2. **Average monthly river flow volume (kcfs) during the TDG monitoring season at the Wells Project in 2012 compared to the previous 42-year average (1969-2011), by month.**

Month	1969-2011 Mean	2012 Mean	Percent Difference from 42-year Average
April	115.6	174.1	+151%
May	149.4	217.2	+145%
June	164.5	232.9	+142%
July	132.2	253.8	+192%
August	104.6	158.7	+152%

All	133.3	207.34	+156%

2.2 Fish Spill Program

Wells Dam is a hydrocombine, where the spillbays are located directly above the turbine water passages. Research at Wells Dam in the mid-1980s demonstrated that a modest amount of spill could be used to effectively guide a high proportion of the downstream migrating juvenile salmon away from the turbines and into a surface oriented bypass system. A JBS was subsequently developed at Wells in the late 1980s. The Wells Dam JBS was engineered based on biological research and hydraulic modeling, and utilizes constricting flow barriers deployed in five of the eleven spillbays to effectively attract and safely guide fish through the project. The Wells Project JBS has since proven to be the most efficient system on the mainstem Columbia River, providing high levels of fish protection that has met approval of fisheries agencies and tribes (Skalski et al. 1996). The survival performance measures contained within the Federal Energy Regulatory Commission (FERC) approved Anadromous Fish Agreement and Habitat Conservation Plan (HCP) have been consistently exceeded, with a three-year survival average of 96.2% for juvenile steelhead and Chinook salmon (Bickford et al. 2001). The results from a fourth year of survival study at Wells Dam in 2010 (Bickford et al. 2011) confirmed past study results by documenting that survival through the entire Wells Project is in excess of 96.4% for juvenile spring migrating anadromous fish (see Section 3.1.2 below).

2.3 Fish Spill Quantities and Duration

The Wells Dam JBS uses up to 2,200 cfs per spillbay, though one or more of the flow barriers may be removed to provide adequate spill capacity to respond to plant load rejection. Under normal conditions, however, the JBS will use roughly six to eight percent of the total river flow for fish guidance. The increased spill has a small influence on TDG production (~0-2%) while providing a safe, non-turbine passage route for over 92% of the spring and 96% of the summer migrating juvenile salmonids. The JBS was operated on a fixed schedule between April 12th and August 26th from 2003 to 2011. The HCP Coordinating Committee (HCP CC) retains annual operating oversight that includes the potential to operate the JBS as early as April 1st and as late as August 31st to ensure that 95% of the spring and summer migration of juvenile salmonids is provided a safe, non-turbine passage route past Wells Dam. In early 2012, prior to the start of the 2012 spill season, Douglas PUD evaluated past performance of the Wells Dam JBS operating dates relative to observed annual run timing (at the Rocky Reach Bypass) for both spring and summer migrants. With that data, a request was made to and granted by the HCP CC to revise operating dates in 2012 to start April 9th and end August 19th. These dates were therefore used in 2012 to operate fish passage spill for migrating juvenile salmonids.

Average monthly spill (calculated from daily averages) at the Wells Project in 2012 was higher than the previous 17-year average. Average spill volume ranged from 12.5 kcfs at the end of the fish spill season in August to 84.4 kcfs in July (Table 3). On June 29Th forced spill reached a maximum hourly value of 167.5 kcfs when more than 312 kcfs of water was passing Wells Dam. These high spill events were attributed to both flow volumes in excess of the Project's hydraulic capacity, and flows in excess of the power system needs and/or transmission system capacity.

Table 3. Average monthly spill (kcfs) during the TDG monitoring season at the Wells Project in 2012 compared to the 16-year average (1995-2011), by month.

	1995-2011		2012	
Month	**Mean**	**Std Dev**	**Mean**	**Std Dev**
April	10.9	7.0	20.6	13.7
May	21.9	20.7	59.0	18.6
June	36.4	39.6	65.4	41.9
July	15.1	11.2	84.4	28.4
August	7.9	2.1	12.5	9.4
Spill Season	18.4	16.1	48.4	37.0

3 IMPLEMENTATION RESULTS

3.1 Fisheries Management

3.1.1 Fish Passage Efficiencies

No fish passage efficiency studies were conducted at the Wells Project in 2012. However, three years of bypass efficiency studies have shown the Wells Dam JBS to be the most efficient juvenile salmonid collection system in the Columbia River with fish passage efficiencies up to 92% for spring migrants and up to 96% for summer migrants (comprised of steelhead, spring Chinook, and sockeye salmon, and summer/fall Chinook salmon, respectively; Skalski et al. 1996).

3.1.2 Survival Studies

No survival studies were conducted at the Wells Project in 2012. In preparation for future subyearling Chinook run-timing and behavior studies, Douglas PUD proceeded with year two of a pilot study to: evaluate the feasibility of capturing wild subyearling Chinook using seining techniques; identify capture locations; and determine whether it is possible to capture enough subyearlings to confidently evaluate migration behavior and timing. Over 19,000 wild subyearling Chinook salmon were beach seined from the reservoir and tagged in the Project area during these efforts.

These juvenile salmon were outfitted with a Passive Integrated Transponder (PIT) tag that allows them to be detected at downstream hydroelectric projects. In subsequent years Douglas PUD expects to estimate survival of these fish when migrating past Wells Dam using similar techniques, toward the goal of demonstrating steady progress in complying with the HCP passage survival standards for subyearling summer/fall Chinook. To date, over 2,800 of these fish have been observed at lower river projects including Rocky Reach, McNary, John Day, and Bonneville Dam.

In spring 2010, Douglas PUD conducted a survival verification study with yearling Chinook salmon, a required 10-year follow-up study to confirm whether the Wells Project continues to achieve survival standards of the Wells HCP. Approximately 80,000 PIT-tagged yearling summer Chinook were released

over a 30 day period in 15 replicates. Study results indicated that juvenile Chinook survival from the mouth of the Okanogan and Methow rivers averaged 96.4% over the 15 replicate releases of study fish, and confirms the results from the three previous years of study documenting that fish survival through the Wells Project continues to easily exceed the 93% Juvenile Project Survival Standard required by the HCP (Bickford et al. 2011).

3.2 Biological Monitoring

In 2012, Columbia River flows at Wells Dam were the 3rd highest on record with total river flow past Wells Dam during the months of April through August almost twice the long-term historic average. Over 42 years of operation, only 1972 (218.8 kcfs) and 1997 (207.7 kcfs) had higher average monthly flows than 2012 (207.3 kcfs). As a result of high flows, high volumes of forced spill throughout the mid-Columbia system resulted in prolonged, elevated TDG levels.

The 2012 Wells Project GAP includes the National Marine Fisheries Service (NMFS) recommendation to sample for Gas Bubble Trauma (GBT) in juvenile salmon when hourly tailrace TDG levels exceed 125% saturation (NMFS 2000).

In response to elevated TDG levels in the tailrace and as required by the 2012 Wells Project GAP, biological monitoring was initiated by Douglas PUD on May 3rd and continued on days subsequent to 125% TDG exceedances below Wells Dam. On June 29th Douglas PUD switched to a three day a week sampling effort since TDG in the tailrace was sustained for 8 days as was discussed with Ecology (Pat Irle, Pers. Comm.). Douglas PUD continued to monitor TDG conditions and biological responses until July 25th, when TDG concentrations in the tailrace fell below 125%.

Over the course of the biological monitoring period five juvenile anadromous fish species were examined, including spring and summer Chinook, steelhead, sockeye and coho. Douglas PUD biologists sampled juveniles on 24 days over a three month span (May 3 to July 25). An average of 23 ±18 (standard deviation) juveniles were sampled on each of these days, across a TDG range of 118.1-130.6% (daily mean; Rocky Reach forebay). In total, staff examined 562 juvenile fish across this TDG spectrum, with only 7 of them showing signs of GBT expression. In addition, Douglas PUD staff and Washington Department of Fish and Wildlife (WDFW) examined over 800 adult salmon captured at Wells Dam fish ladders during broodstock collection activities with none showing signs of GBT despite sampling fish when TDG was in excess of 125% in the Wells tailrace (Gingerich and Patterson 2011).

Overall, GBT expression in juvenile salmonids examined at Rocky Reach was very mild with only 1.25% of all fish showing signs of mild GBT expression. Similarly to 2011, coho appeared to be the most susceptible to a given concentration of TDG relative to other species (Gingerich and Patterson 2011).

3.3 Water Quality Forums

Douglas PUD has actively participated in regional water quality forums with Ecology, WDFW, NMFS, Tribal Agencies, the US Fish and Wildlife Service, the USACE, and other mid-Columbia PUDs (i.e., Grant and Chelan counties). Specific forums include the Trans-boundary Gas Group, Columbia Basin meetings

with Ecology, and the Sovereign Technical Team Water Quality Work Group. These meetings allow for regional coordination for monitoring, measuring, and evaluating water quality in the Columbia Basin and support ongoing Upper Columbia River Treaty review analyses that will provide a foundation for Treaty negotiations between Canada and the U.S. Douglas PUD will continue its involvement in water quality meetings for further coordination with other regional water quality managers.

3.4 Physical Monitoring

3.4.1 Overview

TDG monitoring at the Wells Project has occurred since 1984 when forebay stations were first established. TDG monitoring in the tailrace of Wells Dam began in 1997 by actively collecting data at four points across the width of the river. Based on these data, the location for a fixed monitoring station was established in 1998. Subsequent analysis verified that both monitoring station locations are appropriate and representative of the river conditions, particularly during high flows (EES et al. 2007; Politano et al. 2009). TDG monitoring at the Wells Project currently encompasses the fish passage season and a majority of all forced spill, beginning April 9th and continuing until August 19th. As part of Douglas PUD's Quality Assurance/Quality Control (QA/QC) measures, the TDG sensors are serviced monthly for maintenance and calibration. Data is collected at 15-minute intervals at the Wells Project over the entire fish spill season (typically April 1st – August 31st but may be adjusted per HCP consultation. See section 2.3 above).

3.4.2 Data Evaluation and Analyses

Hourly TDG monitoring data were retrieved from the USACE, Northwest Division for three monitoring locations: the forebay of Wells Dam (WEL), tailrace of Wells Dam (WELW), and forebay of Rocky Reach Dam (RRH). The data were partitioned to include only readings obtained during the fish spill season (April 9th to August 19th). Data were stratified by monitoring site, ascending date, and ascending time. The Ecology-approved 12C-High method was used to obtain TDG measurements for comparison to numeric criteria and evaluation of compliance.

During the 2012 monitoring season, the TDG criterion for the forebay of Wells Dam was exceeded 125 of 133 days (94.0) when using the water quality standard of 110%. When using the 115% fish waiver standard exceedances occurred on 62 of 133 days or 46.6% of the time (Figure 3). Figure 3 below depicts the incoming water as a 12-C high, where the bottom dashed line is the 110% standard and 115% is the inapplicable fish passage waiver criteria. Only on 8 days of the 133-day fish spill season (6.0%) did Wells Dam receive water in compliance with the 110% water quality standard.

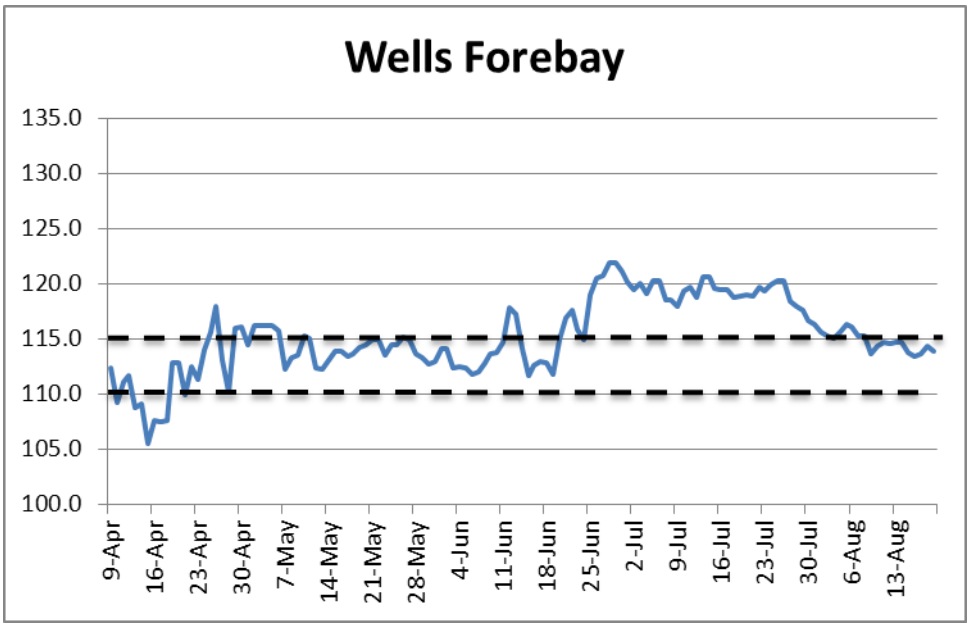

Figure 3. 12-C High TDG concentration in the Wells Forebay during 133 fish spill days in 2012.

Flood control spill started early and remained high throughout most of the fish passage season at Wells Dam. As a result of these high flows, high volumes of forced spill resulted in prolonged, elevated levels of TDG throughout the Columbia River system. The primary source of elevated TDG entering the mid-Columbia has been the operation of federal projects upstream of Wells Dam; primarily Chief Joseph and Grand Coulee dams. Although spill deflectors at the Chief Joseph Dam strip some dissolved gas from Grand Coulee flows, TDG levels in the Wells Dam forebay were consistently above the 110% and 115% forebay compliance criteria in 2012. At Grand Coulee Dam, spill operations produced TDG levels above 115% beginning in early April. TDG levels in the Grand Coulee Dam tailrace remained high and peaked over 120% in June. Concentrations remained above 115% until the end of July (Figure 4). TDG concentrations in the Chief Joseph tailrace were similar to those observed at Grand Coulee where the 110% TDG standard was rarely achieved.

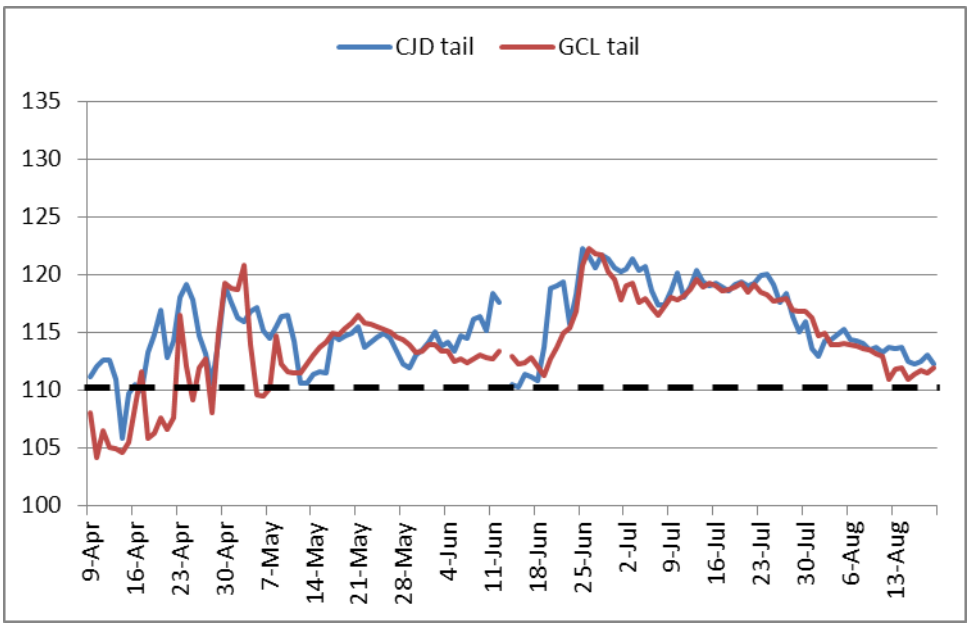

Figure 4. **TDG concentration in the tailrace of Grand Coulee (GCL tail) and Chief Joesph (CJD tail) dams during the 2012 fish spill season. The solid line represents the applicable 110% state water quality standard.**

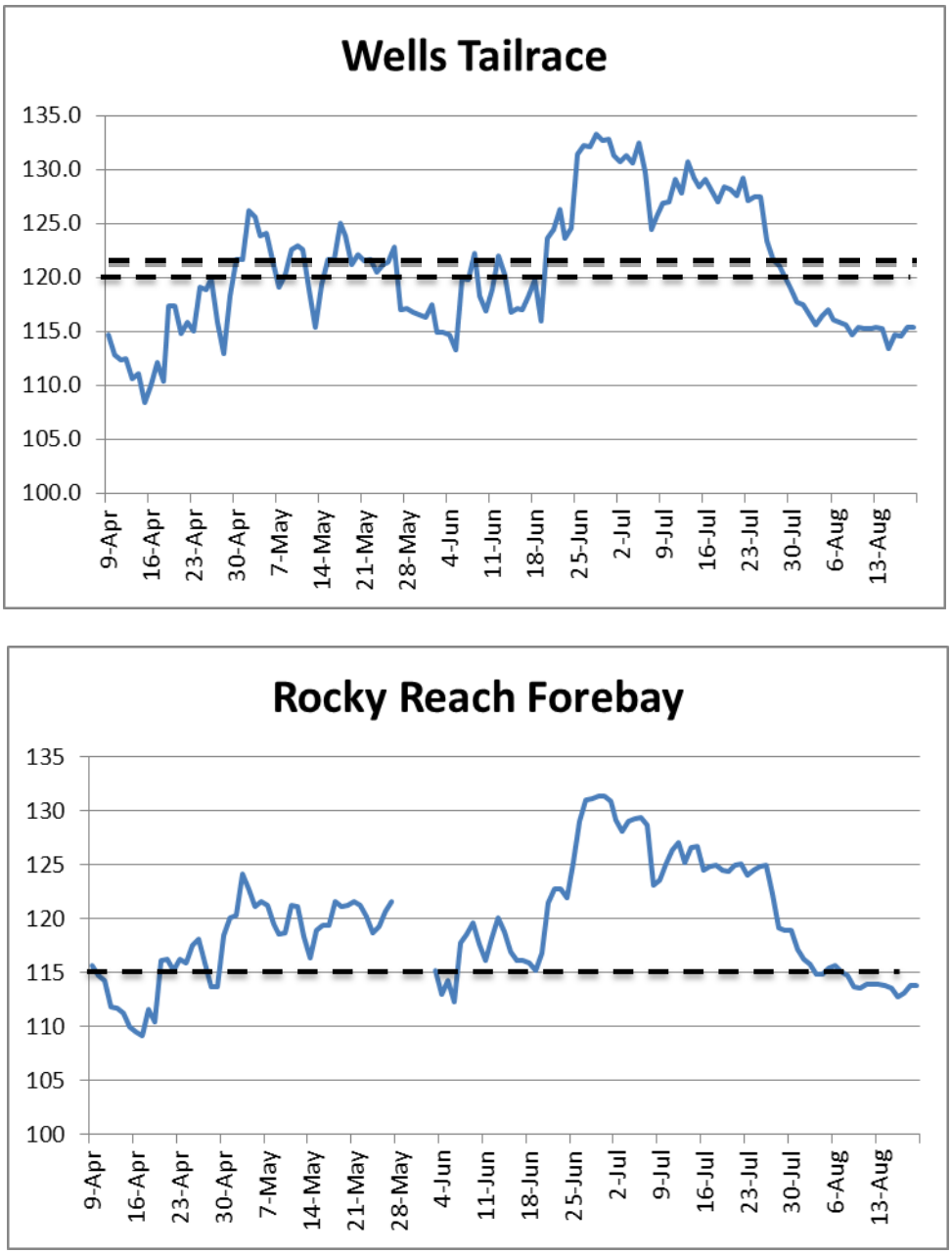

Figure 5. **Daily 12-C High TDG measurements (percent saturation) from Wells Dam tailrace (WELW) and Rocky Reach Dam forebay (RRH) during the 2012 monitoring season. Reference lines are at the 120% and 115% compliance marks. Note that the sensor maintained by Chelan PUD in the Rocky Reach forebay failed on May 28th and was inoperable until June 1st.**

As described in the 2012 GAP there are three compliance criteria for the 2012 fish passage waiver that must be met in association with the operation of the Wells Project: 1) average TDG in the tailrace cannot exceed 125% for one hour or 2) 120% for 12 continuous hours (12C-High); and 3) TDG in the downstream Rocky Reach forebay cannot exceed 115% 12C-High. These compliance criteria are waived when flows exceed the 7Q-10 flow (246 kcfs) or when incoming water is out of compliance (>115% TDG 12C-High) in the Wells Dam forebay and Wells Dam doesn't further increase TDG in the noncompliant water it is receiving. The Wells Dam compliance performance for the 2012 fish spill season are found in table 4, and are specifically summarized below in text.

Table 4. Wells Dam compliance performance for the 2012 fish spill season.

	Compliance	
	Days with 7Q10 flows removed[1]	**Considering 7Q10 flows**
Wells Tailrace 125% hourly standard		
Days out of compliance	2	2
Spill/bypass season	77	133
DCPUD Percent compliant	**97%**	**98%**
Wells Tailrace 120% 12C-High standard		
Days out of compliance	14	14
Spill/bypass season	77	133
DCPUD Percent compliant	**82%**	**89%**
Rocky Reach Forebay 115% 12C-High standard		
Days out of compliance	44	44
Spill/bypass season	77	127[2]
DCPUD Percent compliant	**43%**	**65%**

[1]Days during 2012 fish spill season with flows exceeding 246.0 kcfs (56 days) have been removed from the analysis. The compliance analysis does not factor incoming TDG that was routinely out of compliance via federal projects above Wells Dam.
[2]Five days removed from analysis because of sensor failure.

Wells Tailrace 125% hourly standard

In the Wells Dam tailrace, the hourly average TDG value exceeded 125% for 752 hours on 41 of 133 days during the spill season. On 39 of the 41 days when TDG values exceeded 125%, flows at the Wells Project exceeded the 7Q-10 flows. As a result, Wells was out of compliance with the 125% TDG standard on 2 days out of 133 days (98% compliant). On the remaining 2 days when flows were less than 246 kcfs, TDG in the Wells forebay exceeded 110% on both days and 115% on one of the two days. Once 7Q-10 days were removed from the analysis compliance fell 1% to 97% (Table 4).

Wells Tailrace 120% 12C-High standard

There were a total of 65 days during the 133 day fish spill season where the 120% 12C- High threshold was exceeded (Figure 5). On 51 of those 65 days, flows at the Wells Project exceeded the 7Q-10 value.

Therefore, Wells Dam was 89% compliant with the 120% 12C-High standard for TDG. On all 14 of the non-compliant days, Wells Dam received water from the federal system that was above the state standard of 110% and on five of those days forebay water was at or above 115%. Once 7Q-10 days were removed from the analysis compliance fell 7% to 82% (Table 4).

Rocky Reach Forebay 115% 12C-High standard

The 12C-High TDG value in the Rocky Reach forebay exceeded 115% on 98 of 127 days (five days were removed from this analysis since in late May the Rocky Reach forebay probe failed; Figure 5). Of the 99 days when the standard was exceeded in the Rocky Reach forebay, daily average flows exceeded 7Q-10 on 56 days. Therefore, Wells Dam was 65% compliant with the 115% 12C-High standard for TDG. Of the remaining 44 days, Wells forebay exceeded 115% TDG on 17 days and exceeded 110% on the remaining 24 days. Once 7Q-10 days were removed from the analysis compliance fell to 43% (Table 4).

Compliance Summary

At the Wells Project, average compliance was exceptionally high, given that it was the 3rd highest fish spill flow season on record, and Wells Dam had reduced turbine capacity related to unscheduled maintenance on Unit 6 and the continued unscheduled delay in rebuilding Unit 7. Finally, the compliance criteria averages would have been at or near 100% if incoming TDG violations from Chief Joseph Dam were factored into the compliance analyses (See table 5).

Table 5. TDG Concentration of Water Received at Wells Dam during 2012 fish spill season (133 days).

	TDG standard	Number of days in compliance in a 133 day season	Days in Compliance with TDG Standards (%)
USACE compliance	110%	8	6%
	115%	71	53%

3.5 Non-fish Bypass Season

During the non-fish passage period (January 1 to April 1 and August 31 to December 31), TDG is not currently collected at the Wells forebay and tailrace fixed monitoring stations. Non-spill flows at Wells Dam (through the turbine units and fishways) generate little to no additional dissolved gas. Spill outside the fish passage adjustment period is uncommon, but was higher in 2012 than most years since the federal system decided to draft Grand Coulee Dam aggressively in March of 2012. Starting in April 2013 Douglas County PUD will begin montoring year round and subsquent TDG annual reports will include compliance performance during non-fish bypass season.

4 DISCUSSION OF GAS ABATEMENT MEASURES

4.1 Operational

In 2012, high spring and early summer river flows throughout the Columbia River basin resulted in flows at Wells Dam that were the 3rd highest on record for the month of April through August (since 1969). Spill at the Wells Project started early, and was almost 1.5-2.0 times the long term historical average (1969-2011). In the months of May, June and July, average monthly discharge was above 215 kcfs. In addition, from June 19th to July 26th hourly values greater than 246.0 kcfs occurred every day (Table 2); a threshold above which the Wells Project is not required to meet with Washington State WQS for TDG. During spill season, there were a total of 36 days (27.1%) when daily average flows at Wells Dam were above 7Q-10 flood flows. In addition, 56 days (42.1%) had one or more hourly values above 246 kcfs. As a result of high flows, increased spill volumes throughout the mid-Columbia system resulted in prolonged, elevated levels of TDG. Similar to 2011, the operation of Grand Coulee Dam, coupled with historical and sustained high flows from April through the beginning of August were the primary sources of elevated TDG entering Wells Dam and the mid-Columbia system (Figure 2 & 6).

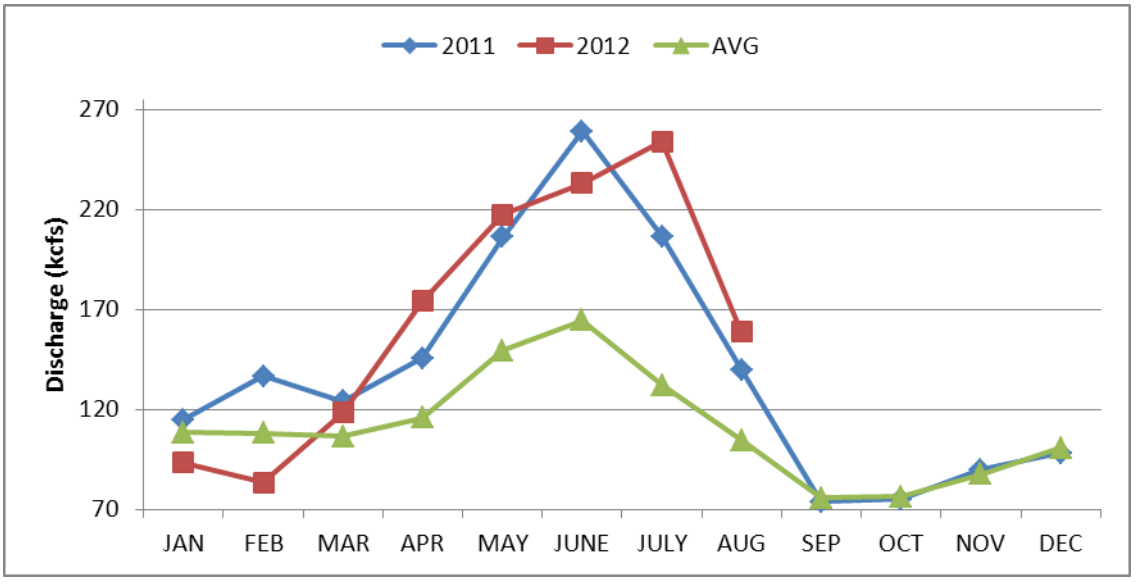

Figure 6. **Average discharge past Wells Dam in the years 2011, 2012 compared to the 42 year average.**

At Grand Coulee Dam, spill operations produced TDG levels between 110-125% between late April and early August. Although spill onto deflectors at the downstream Chief Joseph Dam (the next downstream facility) strips some dissolved gases from Grand Coulee flows, TDG levels in the Wells Dam forebay remained consistently above the 110 forebay compliance criteria. During the spill season, incoming waters to Wells Dam were above the 110% TDG waiver criteria a total of 125 out of 133 days (94.0%). In addition, incoming waters to Wells Dam were above 115% on 62 out of 133 days (46.6%). Washington

State WQS require TDG compliance at Wells Dam even when the dam is receiving water out-of-compliance. This standard skewed performance metrics at Wells Dam since no violations below Wells Dam occurred when incoming water was compliant.

Since the completion of spill deflectors at Chief Joseph Dam in 2008, there has been a shift in federal spill operations to upstream facilities resulting in a significant increase in the amount of spill at Grand Coulee and Chief Joseph dams. This recent increase in the amount of spill has resulted in a dramatic increase in the volume of water that is supersaturated with TDG entering the mid-Columbia system. However, TDG performance was marginally lower at Chief Joseph in 2012 than they were in 2011. The mass influx of supersaturated water has resulted in significantly higher TDG concentrations observed in the forebay of Wells Dam and throughout the mid-Columbia River reach.

Douglas PUD implemented the Ecology-approved GAP during the entire 2012 spill season utilizing the lessons learned during previous years of spill evaluation at the Wells Project. The 2012 Spill Playbook was an important element in managing TDG at Wells during the fish passage season. At the Wells Project, TDG compliance was exceptionally high, given that 2012 had the 3rd highest fish spill season flows on record (April-August; see Figure 6), and Wells had reduced turbine capacity related to unscheduled maintenance on Unit 6 and the prolonged rebuild of Unit 7. Finally, the compliance average would be at or near 100% for Wells Dam if incoming TDG violations from Chief Joseph could have been eliminated.

4.2 Structural

No permanent structural modifications were proposed or conducted in the 2012 monitoring season. Removal of the bypass barrier structures in Spillway 4, 6 and 8 was implemented consistent with the 2012 Spill Playbook.

5 CONCLUSIONS

With the operation of spill deflectors at Chief Joseph Dam in recent years and shifting spill operations by the USACE to this facility and Grand Coulee Dam upstream, there has been an increasing trend of flows with higher levels of TDG entering the Wells Project. FCRPS (Federal Columbia River Power System) spill priorities coupled with two years of 1.5-2.0 times average runoff during the fish spill season have reduced compliance results. In 2012, large volumes of spill at Grand Coulee Dam resulted in a high frequency of flows with TDG levels out-of-compliance entering the Wells Project. Additionally, there were numerous days when flows at Wells Dam were above the 7Q-10 flood flow. In consideration of these conditions, Douglas PUD, through the implementation of its Spill Playbook, achieved high compliance with the TDG waiver standards. If Chief Joseph Dam could attain the non-fish passage WQS criteria of 110%, then the Wells Project would be able to fully comply with the WQS standard. Regardless of these observations, TDG performance at Wells Dam was exceptional in 2012 given the extreme levels of flow recorded and number of turbine units unavailable during the fish passage spill season. These results support the continued implementation of the Spill Playbook to manage TDG production through operational means, and indicate future operational performance should result in

even higher rates of TDG standards compliance in years under more normal 95% unit availability, more normal river flows and with federal compliance of the non-fish passage WQS (110%).

6 REFERENCES

Bickford, S. A., J. R. Skalski, R. Townsend, S. McCutcheon, R. Richmond, R. Frith and R. Fechhelm. 2001. Project survival estimates for yearling summer steelhead migrating through the Wells Hydroelectric Facility, 2000.

Bickford, S. A., T. Kahler, R. Townsend, J. R. Skalski, R. Richmond, S. McCutcheon and R. Fechhelm. 2011. Project survival estimates for yearling Chinook migrating through the Wells Hydroelectric Project, 2010 (2010 spring migrant survival verification study).

EES Consulting, Carroll, J., ENSR, and Parametrix. 2007. Total Dissolved Gas Production Dynamics Study. Wells Hydroelectric Project. FERC No. 2149. Prepared by EES Consulting, Joe Carroll, ENSR, and Parametrix. Environmental Protection Agency (EPA). 1976. Quality Criteria for Water. PB-263943.

Gingerich, A., and B. Patterson. 2011. Douglas PUD Gas Bubble Trauma Biological Monitoring. 2011. Wells Hydroelectric Project. FERC No. 2149. Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

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.

Patterson B., and A. Gingerich. 2011. Memorandum to Pat Irle, Washington Department of Ecology re: Evaluation of TDG at Wells Dam, 2011 mid-season analysis. August 17, 2011.

Pickett, P., H. Rueda, M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Washington Department of Ecology, Olympia, WA. U.S. Environmental Protection Agency, Portland, OR. June 2004. Publication No. 04-03-002.

Politano, M., A. Arenas Amado and L. Weber. 2009. An Investigation into the Total Dissolved Gas Dynamics of the Wells Project (Total Dissolved Gas Evaluation). Report prepared by IIHR-Hydroscience & Engineering, University of Iowa, Iowa City, Iowa.

Skalski, J. R., G.E. Johnson, C.M. Sullivan, E. Kudera, and M.W. Erho. 1996. Statistical evaluation of turbine bypass efficiency at Wells Dam on the Columbia River, Washington. Canadian Journal of Fisheries and Aquatic Sciences 53:2188-2198.

APPENDICES

Appendix 1. Wells Project 2012 Gas Abatement Plan

Appendix 2. Letter of 2012 GAP approval from Washington Department of Ecology

Andrew Gingerich

From: Irle, Pat (ECY) <PIRL461@ECY.WA.GOV>
Sent: Friday, April 06, 2012 3:51 PM
To: Beau Patterson
Cc: McKinney, Charlie (ECY); Andrew Gingerich; Shane Bickford
Subject: GAP for 2012

Hi, Beau –

It looks like your GAP has addressed our comments. As noted in those comments, a QAPP is still needed to fully describe the QA/QC procedures used to monitor TDG. We would like to see the QAPP completed and approved by Ecology before the start of the next (2013) fish spill season.

Thanks again for your work.

Pat Irle, MA, LG
Hydropower Projects Manager
Department of Ecology
Washington State
(509) 454-7864

Appendix 3. Example Hach® HYDROLAB MiniSonde calibration report from the 2012 monitoring season

Appendix 4. Wells Project 2012 Spill Playbook