April 1, 2010

2010 CORPS SPILL CHANGE GUIDANCE
For Columbia and Snake Rivers

Introduction:

The voluntary spill program first began at the John Day dam in 1977, an extremely low water year. It was thought that spill would assist fish passage through the dam and increase fish survival. In 1981, spill began at Lower Monumental dam and the use of sonar to detect fish passage. The time and amount of water to be spilled was based on the numbers of fish detected with the sonar and the dam biologist's judgment. In 1989, there was a 10-year agreement established between Bonneville Power Administration (BPA), state and federal fish agencies and environmental organizations that called for daily spill at John Day, Lower Monumental, Ice Harbor, and The Dalles dams. The US Army Corps of Engineers (Corps) did not sign onto the agreement but agreed to implement the actions it described. This agreement stayed in effect for 3 years, through 1991 when Snake River sockeye salmon was declared endangered under the Endangered Species Act (ESA). As a result, the Corps went into consultation with NOAA Fisheries on how to protect listed salmon. Through the subsequent years, more fish were listed as endangered. In 1992, the spring/summer Chinook and fall Chinook were listed. In 1998, chum and steelhead were listed. By 2000, 12 Evolutionarily Significant Units (ESU) of fish were listed as endangered. In 2005 19 more ESU were listed.

The spill program with daily spill was further developed and was written into the first Biological Opinion issued in 1995 and all the subsequent Biological Opinions. The 2004 Updated Proposed Actions required the Action Agencies (The Corps, BPA, and Bureau of Reclamation) to provide a certain amount of spill from the various dams to aid juvenile fish migration.

Judge Redden issued a December 29, 2005 court decision that declared the 2004 Biological Opinion as inadequate and the federal agencies were ordered to remand it. The new Biological Opinion is under litigation so the Corps developed the Fish Operations Plan (FOP) which can be found at http://www.nwd-wc.usace.army.mil/tmt/wqnew/

As further fish operation decisions are made through court cases and as fish research provides more information about fish migration and technologies to assist it, the amount, method and approaches toward spill changes too. These changes are discussed and agreed upon through regional forums and incorporated into the Water Management Plan. As a result, this spill change guidance document is updated annually to reflect the various changes that were agreed upon regionally and that affect the Corps spill program.

The Factors that Affect Spill Levels:

There are a total of 24 factors to consider when determining how much water will be spilled at the Corps dams. The following is a list of these factors with a discussion:

1. **2010 Spill Guidance Table:** The Spill Guidance Table called Table 1 provides spill amounts, times, planning dates, and minimum generation requirements for the projects

that provides voluntary spill for juvenile fish passage. This table is derived from many discussions and agreement with Corps attorneys and policy people. Since the spill levels at each project may be modified from year-to-year based on decisions made through the regional forum process or through the court, this table is updated either annually or biannually. The spill levels are expressed as a minimum or maximum spill in kcfs, as a % of river flow, or as a spill cap. For example, Bonneville's *minimum* spill level is 75 kcfs and Lower Granite has a *maximum* spill of 20 kcfs using the RSW for 24 hours. Examples of spill in % of the total river flow are JDA with 30% 24 hours per day. The state standards gas cap of 120% in the tailwater and 115% in the forebay is examples of state standards restricting spill levels based on the total dissolved gas levels.

Table 1
2010 FOPs Spill Table

Project	Planning Dates [A & B]	Time	Spill Amount [C]
Lower Granite	April 3 - June 20	24 hours per day	20 kcfs
Lower Granite	June 21-August 31	24 hours per day	18 kcfs
Little Goose	April 3 - August 31	24 hours per day	To the spill cap up to 30% of project outflow
Lower Monumental	April 3 - June 20	24 hours per day	To the spill cap
Lower Monumental	June 21-August 31	24 hours per day	17 kcfs
Ice Harbor	April 3 - April 27	0500-1800	45 kcfs during the day
Ice Harbor	April 3 - April 27	1800-0500	To the spill cap
Ice Harbor	April 28 - July 12	24 hours per day	Alternating between to the spill cap up to 30% vs. 45 kcfs during the day/spill cap at night
Ice Harbor	July 13 - August 31	0500-1800	45 kcfs during the day
Ice Harbor	July 13 - August 31	1800-0500	To the spill cap
McNary	April 10 - June 19	24 hours per day	To the spill cap up to 40% of project flow
McNary	June 20-August 31	24 hours per day	To the spill cap up to 50% of project flow
John Day	April 10 - July 20	24 hours per day	To the spill cap up to 30% vs. 40% of project outflow
John Day	July 21 - August 31	24 hours per day	To the spill cap up to 30% project outflow
John Day	April 10 - August 31	24 hours per day	Minimum spill is 25% of project outflow
The Dalles	April 10 - August 31	24 hours per day	To the spill cap or 40% of project outflow
Bonneville	April 10 - June 15	24 hours per day	To the spill cap up to 100 kcfs
Bonneville	June 16 - July 20	24 hours per day	Alternating between 95 kcfs /95 kcfs vs. 85 kcfs during the day/121 kcfs at night
Bonneville	July 21 - August 31	24 hours per day	75 kcfs during the day/GC at night
Bonneville	April 10 - June 20	24 hours per day	Minimum spill is 75 kcfs
Bonneville	June 21 - August 31	24 hours per day	Minimum spill is 50 kcfs

A - No voluntary spill from April 10 to June 14 in years when forecasted seasonal average flows are less than 125 kcfs.

B - No voluntary spill from April 3 to May 31 in years when forecasted seasonal average flows are less than 65 kcfs on the Snake River.

C - Spill cap is defined as the maximum spill amount that will keep the High 12 hr %TDG average within the State WQ standards of 115% in the forebay or 120% in the tailwater.

2. **Fish Tests Cause Changes to the ESA Requirements:** The spill levels established in the 2010 Fish Operation Plan reflect the proposed fish tests planned for the 2010 spill season. When fish tests are planned, the Water Management Plan is modified and the

proposed fish tests are discussed in the Spring Summer Update of the Water Management Plan. The tests that are planned for each spill season is also discussed in the Fish Passage Plan, Appendix A. When a fish passage test is planned that will modify the regularly established spill regime, then it receives special attention since it would cause TDG levels to fluctuate. The fish tests for the 2010 spill season that will change the spill regime are:

- **Ice Harbor:** *Fish Passage and Survival Evaluation Test* – Test conditions will include spill alternating between to the spill cap up to 30% of project outflow and 45 kcfs daytime/spill cap at night. Test starts on April 28 and will continue through June, 24 hours per day. The purpose of this study is to evaluate the fish passage and survival passing the spillway weir.
- **John Day:** *Fish Passage and Survival Evaluation Test* – Acoustic telemetry will be used to evaluate the performance of two Top Spillway Weirs (TSW) from April 20 to July 20. Test conditions will include spill of either 30% or 40% of project outflow for 24 hours per day. The purpose of this study is to evaluate the fish passage and survival passing the spillway weirs.
- **Bonneville:** The Bonneville fish passage and survival test spill operation was randomly alternating spill in two day blocks of 85 kcfs during daytime hours and to 121 kcfs at night vs. a constant 95 kcfs for 24 hours per day from June 16 to July 20. Although the teletype for the fish test was issued on June 16 it could not be implemented until July 2 because flows were too high.

3. **Gas Caps:** The Washington rule adjustment establish TDG limits of 115% for forebay gages and 120% for tailwater gages and the Oregon TDG waiver establish TDG limits of 120% for tailwater. These TDG limits are called gas caps. These state standards TDG gas cap are embodied in the daily spill caps that are issued in spill priority list to the projects during spill season. In order to address the conditions of the variances, the Corps tracks the following information:

    a. High 12-Hour Average TDG: Oregon waiver sets TDG standards based on the average of the 12 highest TDG levels measured in a given calendar day. Calculated High 12-Hour Averages for TDG are posted on the web at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/or/

    b. High Consecutive 12 hour TDG Average: Washington waiver sets TDG standards based on the average of the 12 highest consecutive TDG levels in a 12 hour period. Calculated High 12-Hour Averages for TDG are posted on the web at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/wa/ .

    c. Combined Oregon and Washington methods for High 12 Hour Average: A web report that combines both the Oregon and Washington method for calculating the high 12 hour average can be found at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/

d. Daily TDG Spill Decisions Form: The Corps fills out daily TDG spill decision form with the information that caused us to change the spill levels. The type and degree of exceedance is also documented. This form documents the spill changes.

e. Instance Tracking: The Corps keeps track of the date, number, reason and actions taken for the days that TDG levels exceed state water quality standards. The instance tracking summary is discussed at the TMT meetings and available on the TMT web page at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

f. List of Daily Spill Caps: The Corps maintains a list of the spill caps determined for each project. An annual list of spill caps for all of the projects can be found on the "M" server (rccfiles wmserver): M://Water Quality/Spill Caps/2007_Spill_Caps. There is also a historical spill cap list that goes back to 1997, which can be found at the same location under /SpillCaps_1977_xxxx. An annual summary of the spill caps for all the projects can be found at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/caps/

4. **Programs to Evaluate Spill Data:** The Corps has developed several programs that summarize spill data, which are used in spill level change decisions. These programs are:

   a. Amount of Voluntary Spill: The Corps Project Plots program tracks of the amount of voluntary spill that represents FOP spill for fish. The project plots program generates graphs of the FOP spill, actual spill, TDG levels and flow that are used during the daily spill evaluations and changes.

   b. Percent Spill: There is a program that calculates the percent of total river flow that is spilled at Little Goose; Ice Harbor; McNary; John Day and The Dalles. This is a simple calculation that uses the following equation: % Spill= spillway discharge/total project flow. The results of this calculation can be found on the percent spill report shown on: http://www.nwdwc.usace.army.mil/tmt/documents/ops/spill/

   c. Tributary Data Reports: There is a report that shows the flow and water temperature for the tributaries that flow into the Lower Snake and Columbia Rivers. The Tributary Data report for a total of 25 tributary gauges with hourly flow and/or temperature data can be found at: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/tribs/. This data was added to the SYSTDG model so the tributary influences to TDG levels on the Lower Snake and Columbia Rivers will be considered.

   d. Project Data Reports: The Corps has reports that summarize the project data and they can be found at http://www.nwd-wc.usace.army.mil/tmt/wq/historical/

5. **Bonneville Daytime Spill Schedule:** The definition of daytime and nighttime effects how long the spill levels are maintained. At Bonneville, the definition changes

frequently throughout the spill season and the definitions are listed in Table 2 taken from Table BON –5 of the Fish Passage Plan, page BON-13

Table 2
Bonneville Daytime Spill Schedule

Date	Daytime Spill	
	Begin	End
Jan 01 – Jan 19	0700	1730
Jan 20 – Feb 14	0630	1800
Feb 15 – Mar 01	0600	1830
Mar 02 – Apr 02	0600	1930
Apr 03 – Apr 20	0500	2030
Apr 21 – May 16	0500	2100
May 17 – May 31	0430	2130
Jun 01 – Jun 30	0430	2130
Jul 01 – Jul 31	0430	2200
Aug 01 – Aug 15	0500	2145
Aug 16 – Aug 31	0500	2030
Sep 01 – Sep 16	0530	2000
Sep 17 – Oct 04	0600	1930
Oct 05 – Oct 19	0630	1900
Oct 20 – Oct 29	0630	1830
Oct 30 – Nov 30	0600	1700
Dec 01 – Dec 31	0630	1700

6. **Minimum Operating Pool:** The Minimum Operating Pool (MOP) is maintained as part of the fish passage effort. The MOP operations typically begin on the first day of spill season and ends in September to October for the Lower Snake River projects. The MOP forebay elevation becomes important when calculating how much spill can occur. In Table 3, MOP forebay elevations are:

Table 3

MOP and MOP + 1		
Project	**MOP in ft**	**MOP + 1 in ft**
Lower Granite	733	734
Little Goose	633	634
Lower Monumental	537	538
Ice Harbor	437	438

7. **Minimum Spill and Generation During Low Flows:**
When the river discharges are low then low flow conditions exist and minimum spill and minimum generation are an issue. The various projects are entitled to a certain amount of flow for power generation at all times if they choose to use it. Table 4 shows the minimum spill amount that is allowable during low flow and the amount of flow (kcfs)

associated with the minimum generation requirements. The information in Table 4 is taken from the 2010 FOP.

Table 4
Minimum Spill and Generation Table

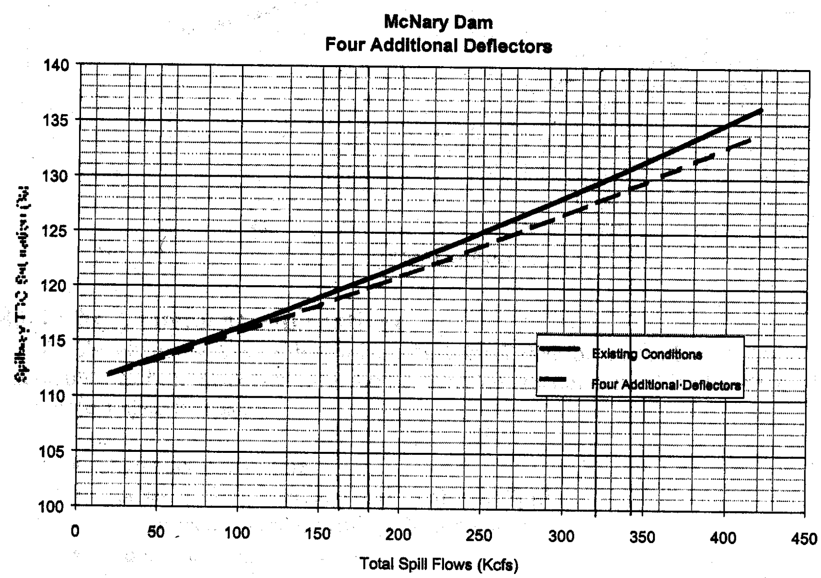
Project	Units	Minimum Generation Requirements kcfs *
Lower Granite	units 1-3	11.3 - 13.1
	units 4 - 6	13.5 - 14.5
Little Goose	units 1-3	11.3 - 13.1
	units 4 - 6	13.5 - 14.5
Lower Monumental	unit 1	16.5 - 19.5
	units 2-3	11.3 - 13.1
	units 4 - 6	13.5 - 14.5
Ice Harbor	units 1-3	8.5 - 10.3
	units 4 - 6	8.5 - 10.3
McNary	N/A	50 - 60
John Day	N/A	50 - 60
The Dalles	N/A	50 - 60
Bonneville	N/A	30 - 40
*at typical head		

8. **General Rule of Thumb Guidance:** The following basic adjustment guidance is a rule-of-thumb method used in a general way.

    a. Snake projects – 5 kcfs change in spill results in about 2% change in TDG.
    b. Columbia projects – 10 kcfs change in spill results in about 2% change in TDG.
    c. 1 ^{0}F water temperature rise will result in about 1% TDG rise. See #15 for more information.
    d. Little Goose tailwater TDG levels need to be at about the same as Lower Monumental forebay because there is no degassing between the two dams. There are times when the % TDG in the Lower Monumental forebay can be higher than the Little Goose tailwater.

9. **DGAS Report Project-by-Project Guidance**: Project TDG Performance Graphs, derived from the DGAS studies, provide the relationship between spill flows and TDG levels at a constant temperature. Figure 1 is an example of one of the graphs that exists for the eight Corps projects on the Lower Columbia and Snake Rivers (use existing conditions).

Figure 1



10. **Travel Time Guidance:** Knowing the amount of time it takes for water to travel from one project to the next is important in making TDG decisions. Table 5 provides estimated travel times for water to travel from one project to the next on the Columbia and Snake Rivers.

Table 5

COLUMBIA/SNAKE RIVER TRAVEL TIMES
Days for Water to Travel through Reservoirs

PROJECT	VARIABLE RIVER FLOW RANGES						
	50K*	75K*	100K*	150K*	200K*	250K*	300K*
From the Confluence of the Snake and Clearwater Rivers to Lower Granite Dam	4.44	2.96	2.22	1.48	1.11	0.89	0.74
From RM 146.5 (Six miles up the Snake River and the beginning of the Lower Granite	4.72	3.15	2.36	1.57	1.18	0.94	0.79
From Lower Granite to Little Goose	5.35	3.57	2.68	1.78	1.34	1.07	0.89
From Little Goose to Lower Monumental	3.73	2.49	1.86	1.24	0.93	0.75	0.62
From Lower Monumental to Ice Harbor	4.02	2.68	2.01	1.34	1.00	0.80	0.67
From Ice Harbor to McNary	13.05	8.70	6.53	4.35	3.26	2.61	2.18
From McNary to John Day	22.86	15.24	11.43	7.62	5.72	4.57	3.81
From John Day to The Dalles	3.11	2.08	1.56	1.04	0.78	0.62	0.52
From The Dalles to Bonneville	7.18	4.79	3.59	2.39	1.80	1.44	1.20
From Bonneville to Camas/Washougal	----	1.3	1	0.8	0.6	0.56	0.49

* These are estimated travel times determined from the theoretical residence time in each pool (volume/discharge). Mike Schneider is the author of these times and they are in agreement with TDG fronts observed with actual data

In order to know the travel time for water to flow from Dworshak to Lower Granite, it is necessary to calculate it in two parts and add them together. The two parts are the travel time from Dworshak to the confluence of the Snake River and the travel time from the confluence of the Snake River to Lower Granite. Tables 6 and 7 show the information used to get the travel time for the Dworshak to Lower Granite reach.

Table 6

DWORSHAK TO CONFLUENCE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	**VARIABLE RIVER FLOW RANGES**					
	5K*	**10K****	**20K***	**30K****	**40K***	**50K****
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	19 hrs	15.6 hrs	12.6 hrs	11.1 hrs	10.2 hrs	9.5 hrs
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	0.79	0.65	0.53	0.46	0.43	0.40

Note: These are estimated theoretical retention times based on information from Mike Schneider.

Table 7

DWORSHAK TO LOWER GRANITE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	**VARIABLE RIVER FLOW RANGES**					
	50K on Snake & 5K on Clearwater	**75K on Snake & 10K on Clearwater**	**100K on Snake & 20K on Clearwater**	**150K on Snake & 30K on Clearwater**	**200K on Snake & 40K on Clearwater**	**250K on Snake & 50K on Clearwater**
From Dworshak Dam to Lower Granite Dam	5.23	3.33	2.53	1.80	1.43	1.20

* These are estimated travel times determined from the theoretical residence time in each pool (volume/discharge). Mike Schneider is the author of these times and they are in agreement with TDG fronts observed with actual data.

11. **Weekend Guidance:** Total River Flow can significantly decrease on weekends, causing a resulting increase in TDG. As a result, the spill caps are usually decreased on Friday.

12. **Monday Guidance**: Beginning-of-the-Week Total River Flows on Monday increase, causing the TDG level to decrease. As a result, the spill caps are usually increased on Monday.

13. **Holiday Guidance**: Total River Flow can significantly decrease on holidays, causing a resulting increase in TDG. As a result, the spill caps are usually decreased on before a holiday.

14. **Degassing Guidance**:
    a. Winds above 10 mph enhance degassing in Columbia Gorge.
    http://www.wunderground.com/US/OR/Hood_River/KDLS.html
    Go to Personal Weather Station: Hood River (near bottom of the webpage)
    b. At flows **above** 200 kcfs at BON, little degassing occurs between BON and Camas.
    c. At flows **below** 200 kcfs at BON, significant degassing occurs between BON and Camas.

15. **Water Temperature Guidance**: Climatic conditions can cause increases in water temperatures, which in turn can cause increases in TDG levels. Using Boyle's gas law, a rule of thumb was developed that 1^{o}C or 1.8^{o}F water temperature change can result in a 2 to 3 % change in TDG saturation. Since we cannot predict water temperature, we use air temperature as found in weather forecast, as a surrogate. The National Weather Service, the Northwest River Forecast Center posts information daily on the forecasted temperatures, which are available at http://137.161.65.209/weather/10_day.cgi. Real-time and historical water temperatures at the projects can be found at the external website: http://www.nwd-wc.usace.army.mil/tmt/documents/ops/temp/ and the temperature string for Dworshak can be found at the internal location: http://www.nwd-wc.usace.army.mil//tmt/documents/ops/temp/carroll/DWR_S1_2005_12.html

16. **Physical Designs**: There are physical designs and system features that have unique affects on spill decisions and spill caps. The spill patterns at John Day and the bottleneck influence at Camas/Washougal are two examples.

- Lower Monumental Spill Pattern – The spill patterns at Lower Monumental are bulk spill patterns with much of the spill going through bays 6 and 8. The patterns are unusual in that there is an increase in spill through those bays and then backing off. This causes the project to be very sensitive to spill cap changes.
- John Day Spill Pattern – The spill patterns at John Day are such that to spill at low levels (80 kcfs) generate the same amount of TDG as spill at high levels (140 kcfs). Spill at about 108 kcfs generate much higher TDG levels than at 80 or 140 kcfs. This anomaly causes difficulty in regulating spill levels. Avoid spilling between 102 and 115 kcfs, especially at 108 kcfs. Spilling at 130 kcfs generates more TDG than 140 kcfs.
- Bottlenecks in the Rivers: – The flow deflectors at certain projects allow higher spill levels than in the past. And as a result, certain projects become bottlenecks in segments of the river. Many of the projects can be operated at 120% but certain projects can not and as a result, are a bottle neck in spill. Lower Monumental can not be operated to 120% TDG or else the Ice Harbor forebay is always exceeding 115%.
- Bonneville's Uniqueness: There are several factors that are unique to Bonneville which play a significant role in producing high number of TDG exceedances at Cascade Island and Camas/Washougal. The factors are:

1. Flow Deflectors: There are flow deflectors at two different levels, both need 12 feet of head to be fully functional as designed. Flow deflectors on bays 1-3 and 16-18 were built at 7 ft, so at a 19ft tailwater elevation or higher; these flow deflectors are not functioning. Flow deflectors on bays 4 -15 were built at 14 ft, so at a 26ft tailwater elevation or higher, these flow deflectors are not functioning. Since the tailwater elevation during April and May was above 19ft all the time and above 26 ft some of the time, some or all flow deflectors were not functioning resulting in numerous TDG exceedances.
2. Topography: The topography of the reach below Bonneville is such that the water can go to a much greater depth (100ft) than other projects but at Bonneville the depth is 15 to 20ft. This results in more gas being produced.
3. Stage Elevation: The stage elevation can experience huge changes, between 6 and 30 ft. This is much more than other projects where the elevation change is between 4 and 6ft.

17. **Physical Limitations:** There are three physical limitations that effects how the fish move or the amount and manner of spill distribution across the channel. These physical limitation are:

- **Screen Lengths**: Because of the screen lengths at Lower Monumental; Little Goose and Lower Granite, it is helpful to fish survival to have a balance of spill amounts between the three projects. Lower Monumental has standard length submersible traveling screens, which are 20 ft long. More fish are able to get under them and end up going through the turbines, resulting in higher fish mortality. Little Goose and Lower Granite has extended length screens, which are about 40 ft long. Less fish are able to get under them
- **The Dalles**: There are physical limitations at The Dalles during 2009 and 2010 because of the construction of the spill wall. Spill bays 10, 11, 13, 16, 18, 19, and 23 are not operational due to wire rope, structural, and concrete erosion concerns. Spill must stay below 160Kcfs.
- **Turbines Out of Service:** On a weekly or daily basis, there are unit outages that will affect the spill volume at the projects. To get the daily updates, go to https://npr71.nwd-wc.usace.army.mil/rccweb/RCCLIST/ and click on the BPA Unit Outages. Major unit outages are also listed in Appendix B of the FOP. There are four turbines on the Columbia or Snake River that will be out of service for two to ten months and they are:

Long Term Unit Outages

- Lower Granite: Unit 3 was forced out of service all year because of a damaged field ground and is waiting for repairs.
- McNary: Four units have been out of service for a month or longer: Units 2 and 7 were out from July 1 through December 28 for a turbine rewinds. Units 3 and 4 were out of service from July 1 through August 28 for transformer replacement.
- The Dalles: Five units have been out of service for a month or longer:
  Four units were out of service for their annual maintenance and turbine blade seal replacement: unit 5 from June 21 through July 28; unit 6 from April 19 through June 10;

unit 11 from June 12 through August 13; unit 13 from April 5 through May 20. Units 11 and 12 were out of service from March 16 through April 27 for station service upgrade.

- Bonneville: Three units have been out of service for a month or longer: Unit 7 continued out of service through June 6 for turbine rehabilitation and generator rewind. Unit 9 continued out of service through October 14 for turbine rehabilitation and generator rewind. Unit 11 continued out of service all year due to cracks in the generator rotor.

18. **Flow Forecast**: The Corps -reservoir regulators run computer programs that generate flow forecast for the Columbia and Snake Rivers. These can be found on an internal server location https://npr71.nwd-wc.usace.army.mil/rccweb/RFS/. The mcol.out.txt is the forecast on the middle Columbia River and the lsnake.out.text is the forecast on the lower Snake River. In these documents, you will see QIQF, which stands for discharge, inflow forecast. QRQF stands for river discharge forecast. HFQF is forebay elevation forecast. To know the meaning of the different abbreviations, see CBT user's manual on https://npr71.nwd-wc.usace.army.mil/

19. **SYSTDG Model**: The Corps will continue to use the SYSTDG model to run daily simulations forecasting the TDG levels. It will be used as a real time operations tool forecasting and hind casting to see what the TDG levels will be or would have been if conditions for a day in the past were entered.

20. **Instance Types**: When TDG levels exceeded the state water quality standards it is considered an "instance". The classifications of the instance types is listed in Table 8 and are documented in the annual TDG and Temperature report. There is a spreadsheet called (The current year) Instance Types found in the current year's spill season information folder that summarize this information.

Table 8
Types of Instances

Type 1 Condition	**TDG levels exceed the TDG standard due to exceeding powerhouse capacity at run-of-river projects resulting in spill above the BiOp fish spill levels. This condition type includes:**
	• High runoff flows and flood control efforts.
	• BPA load requirements are lower than actual powerhouse capacity.
	• Involuntary spill at Mid Columbia River dams resulting in high TDG levels entering the lower Columbia River.
	• Involuntary spill at Snake River dams resulting in high TDG levels entering the lower Columbia River.
Type 1a Condition	**Planned and unplanned outages of hydro power equipment including generation unit, intertie line, or powerhouse outages.**
Type 2 Exceedance	**TDG exceedances due to the operation or mechanical failure of non-generating equipment. This exceedance type includes:**
	• Flow deflectors unable to function for TDG abatement with tailwater elevations above 19 - 26 feet at Bonneville Dam.
	• Spill gates stuck in open position or inadvertently left open.
	• Increased spill in a bulk spill operation to pass debris.
	• Communication errors, such as teletype were transmitted but change was not timely made or misinterpretation of intent of teletype by Project operator.
Type 2a Exceedance	**Malfunctioning FMS gauge, resulting in fewer TDG or temperature measurements when setting TDG spill caps.**
Type 3 Exceedance	**TDG exceedances due to uncertainties when using best professional judgment, SYSTDG model and forecasts. This exceedance type includes:**
	• Uncertainties when using best professional judgment to apply the spill guidance criteria, e.g., travel time, degassing, and spill patterns.
	• Uncertainties when using the SYSTDG model to predict the effects of various hydro system operations, temperature, degassing, and travel time.
	• Uncertainties when using forecasts for flows, temperature and wind.
	• Unanticipated sharp rise in water temperature (a 1.5 degree F. or greater change in a day).
	• Bulk spill pattern being used which generated more TDG than expected.

21. **Unit Availability Assumption**: During an average spill season, there are many units that are out of service for various reasons. Table 9 provides the percentage of turbine capacity available after adjustment for unit outages, 1% peak efficiency requirement, and system reserve obligations. BPA developed these percentages and the Corps reviewed and approved them so that the federal agencies had representative unit outage percentages. These unit outages percentages are the average of the actual month averages in 1999-2001 by project. BPA's Federal Hydro Resources determined those years to be more representative of the future expectation than any periods since due to increased investments in recent years to accomplish more routine maintenance that will pay dividends in reducing forced outage rates in the future.

Table 9

Unit Availability Assumptions During Spill Season in %

PROJECT	APR 1-15	APR 16-30	MAY	JUN	JUL	AUG 1-15	AUG 16-31
Lower Granite	71	80	80	72	59	56	53
Little Goose	71	77	80	78	71	61	54
Lower Monumental	77	82	78	81	75	65	61
Ice Harbor	83	85	85	81	74	72	62
McNary	68	68	69	69	66	64	65
John Day	85	87	86	89	92	88	87
The Dalles	69	71	73	71	70	69	69
Bonneville	72	76	77	74	66	68	68

22. **Full Powerhouse Information**: If any project has a full powerhouse available, than Table 10 provides the turbine capacity available for outside and within the 1% peak efficiency requirement. The Fish Passage Plan proscribes that project turbines are operated within 1% during spill season. Operation outside of 1 % generates more TDG so it is not as fish friendly and is allowed during non-spill season months

Table 10

Full Powerhouse Capacity

Project	Powerhouse capacities outside of 1% (kcfs)	Powerhouse capacities within 1% (kcfs)	One unit capacity (kcfs) - avg	# of Units	Flows that involuntary spill begins	Typical spill cap
Bonneville	288	257	14.3	18	357	100
The Dalles	281	288	13.1	22	408	120
John Day	322	331	20.7	16	491	160
McNary	232	172	12.3	14	312	140
Ice Harbor	106	92	15.3	6	184	92
Lower Monumental	130	115	19.2	6	139	24
Little Goose	130	112	18.7	6	142	30
Lower Granite	130	112	18.7	6	150	38

23. **Actual Powerhouse Generation Capacity Limitations:** There are limitations on how much water the powerhouse generators can physically handle. The full (maximum) powerhouse generation capacity, with all units in operation, is listed below in Table 11. The percentage unit availability shown in Table 11 is multiplied by maximum powerhouse capacity to give the true actual powerhouse capacity. These capacities are lower than full powerhouse and are used to calculate a realistic volume of involuntary spill. These powerhouse generator capacities are shown in Table 11 for the Columbia and Snake Rivers projects. It is important to note that McNary has the lowest generator capacity of the projects on the Lower Columbia and as a result, it will have involuntary spill during June and/or July when other projects are not.

Table 11

Actual Powerhouse Capacity after Adjustments for Outages (in kcfs)

PROJECT	APR 1-15	APR 16-30	MAY	JUN	JUL	AUG 1-15	AUG 16-31
Lower Granite	92	104	104	94	77	73	69
Little Goose	92	100	104	101	92	79	70
Lower Monumental	100	107	101	105	98	85	79
Ice Harbor	88	90	90	86	78	76	66
McNary	158	158	160	160	153	148	151
John Day	276	283	280	289	299	286	283
The Dalles	259	266	274	266	263	259	259
Bonneville	207	221	222	213	190	196	196

24. **Chum Redds Emergence –** During low flow years, the Chum Redds emergence presents a limitation on the amount of spill that can occur at Bonneville Dam and the levels of TDG that the redds can endure. The % TDG that redds can endure is influenced by the Bonneville tailwater elevation.

Two graphs are used together to determine the amount of spill that can occur with a specific tailwater elevation. Figure 2 is the Bonneville Powerhouse Tailwater rating curve from the Bonneville Water Control Manual and it illustrates the relationship between project outflow to tailwater elevation. Figure 2 is used in conjunction with Figure 3, which is a graph that shows the % TDG to outflow that can be used to establish spill levels. Usually this graph or the data is provided to us, which we use to regulate spill levels.

Figure 2
Bonneville Powerhouse Tailwater
Rating Curve

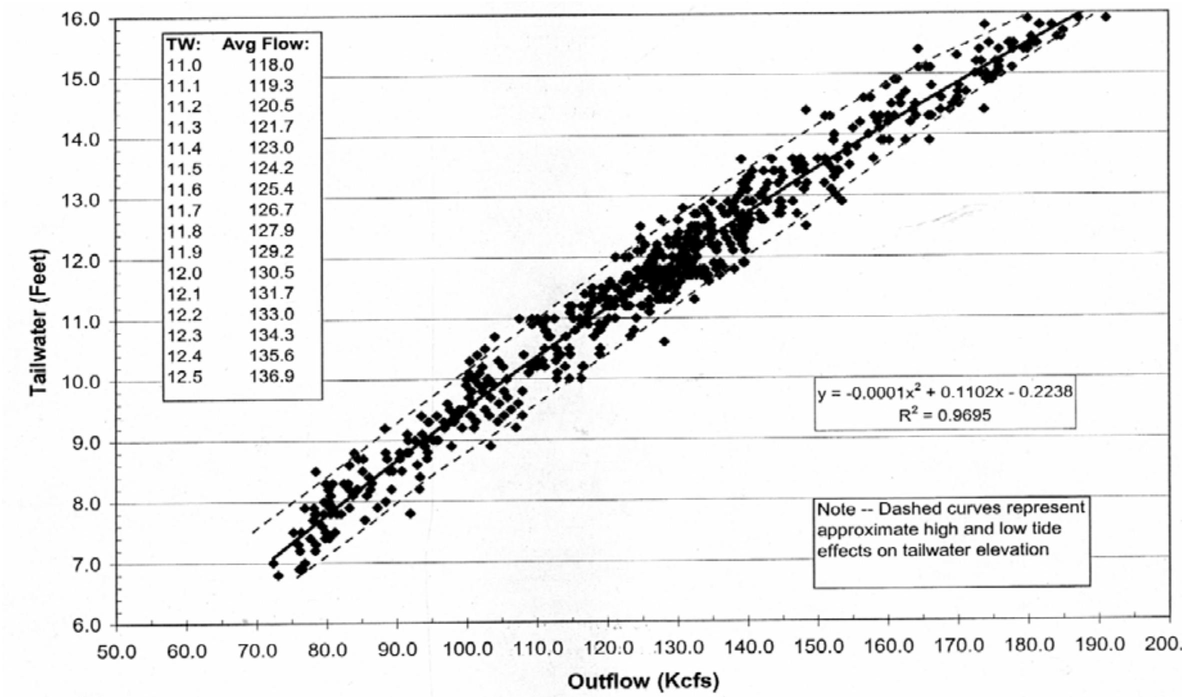
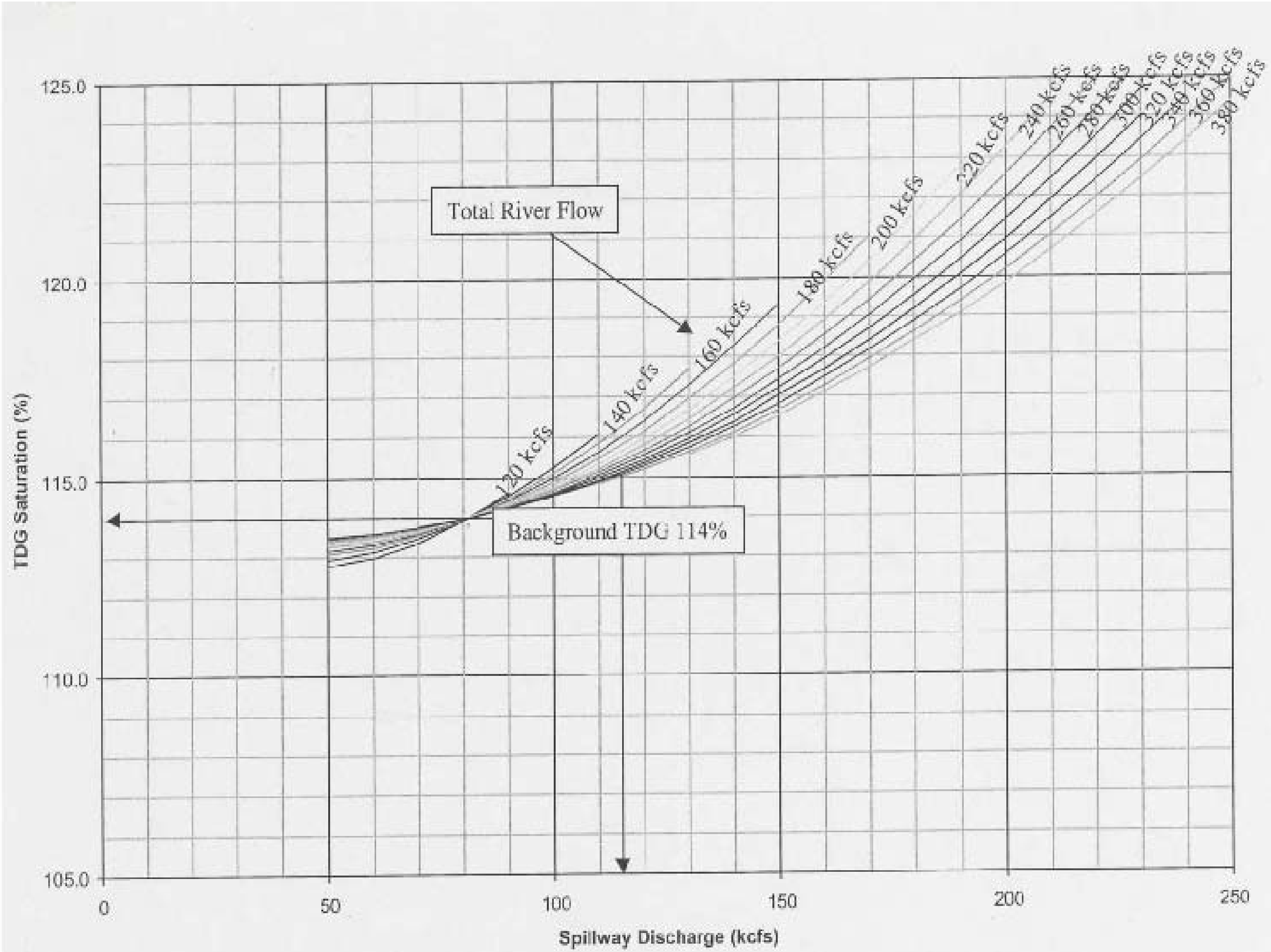


Figure 3


TDG Saturation (%)
125.0
120.0
115.0
110.0
105.0
0
50
100
150
200
250
Spillway Discharge (kcfs)
Total River Flow
Background TDG 114%
120 kcfs
140 kcfs
160 kcfs
180 kcfs
200 kcfs
220 kcfs
240 kcfs
260 kcfs
280 kcfs
300 kcfs
320 kcfs
340 kcfs
360 kcfs
380 kcfs