DRAFT

2005 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, 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 did not sign onto the agreement but agreed to implement the actions it described. This agreement stayed in effect for 3 years, until 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 to protect listed salmon. Through the subsequent years, more fish were listed as endangered. In 1992, the spring/summer Chinook and fall Chinook. In 1998, chum and steelhead were listed. By 2000, twelve different species of fish were listed.

The spill program with daily spill was further developed and was written into the first Biological Opinion issued in 1994 and all the subsequent Biological Opinions. The 2004 Updated Proposed Actions required the Action Agencies (The US Army Corps of Engineers; Bonneville Power Administration and Bureau of Reclamation) to provide a certain amount of spill from the various dams to aid juvenile fish migration. 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 Voluntary Spill Program
The voluntary spill program is a set of actions taken to ensure that the agreed upon amount of water is spilled to aid fish migration and increase fish survival. The voluntary spill program described here involves the eight Corps dams on the Columbia and Snake Rivers. The actions taken to ensure the appropriate amount of water is spilled includes:

1. Establish the order of which dams spill first in the event of involuntary spill, which is called spill priority list.
2. Review all of the real time data and various factors outlined in this spill change guidance document.
3. Based on the data review, develop an proposed spill level for the eight Corps dams on the Columbia and Snake Rivers.
4. Run simulation with the SYTDG model to see what spill levels it suggest for the eight Corps dams
5. Develop a final spill level for the eight Corps dams
6. Coordinate changes to the spill levels with Bonneville Power Administration real time operations staff, the dam operators and Corps RCC real time operations staff

7. Send the cbt teletype out electronically to the Bonneville Power Administration, the dams and real time operations staff
8. Review data and Corps reports that show the amount of spill for the previous date to ensure that the spill prescribed occurred. If not, call Bonneville Power Administration real time operations staff, the dam operators or Corps RCC real time operations staff to find out what happened.
9. Document when, where and why there are TDG exceedances of the 115% and 120% state water quality standards. Use this information to assist in changing the spill levels.

Setting Spill Priority

At least once during spill season, the Corps Water Quality Team develops a spill priority list that gives the order of which dams should spill first in the event of involuntary spill. This list may change several times during the spill season depending on river conditions and other circumstances. The spill priority lists are discussed in the TMT regional forum. When establishing the order of which dams should spill first in the event of involuntary spill, the following factors are what the Corps considers:

- Location of Fish: Consider where the fish are. If TDG levels are at 120% with high involuntary spill, put the projects with the most fish first on the priority list so the fish are benefited the most with the high spill and flows.
- Location of High TDG: When TDG levels are above 120 to 125% with high involuntary spill, put the projects with the most fish last on the priority list so the fish are harmed the least with the high spill and flows.
- Location of Fish Studies: Consider where there are special fish studies and put those projects low on the priority list so the studies can remain intact as designed.
- River Reaches: Consider projects in one of three blocks: Lower Snake; Lower Columbia and Middle Columbia. For example, if several Lower Snake projects need to be moved to low priority on the list, then move the whole block of projects (LWG; LGS; LMN and IHR) to the last.
- Special Operations: Place projects with special operations such as maintenance or project gate malfunctioning last on priority list.
- Collector Projects: During low flow years, place the collector projects (LGS; LWG; LMN; MCN) low on the priority list so that spill is away from them.
- Special Fish Conditions: If there are special fish conditions, such as disease or a special release, then move the project to first place on the priority list so the fish receive the maximum spill.

It is important that the Corps the RCC, Fish Unit is consulted when new spill priority lists are developed and that the proposed spill priority list are discussed in the Regional forum of the Technical Management Team meetings.

The Factors that Affect Spill Levels:
There are a total of 19 factors that are considered when determining how much water will be spilled at the Corps dams. The following is a list of these factors with a discussion:

1. **2005 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 Table 4 of the 2004 Updated Proposed Action (UPA), page 49 found at http://www.salmonrecovery.gov/remand/BiOp_UPA/UPA_final/FinalUPANov242004.pdf and the 2005 Water Management Plan, page 22 found at http://www.nwd-wc.usace.army.mil/tmt/documents/wmp. Further explanation was taken from the Spring/Summer Update, page 11 found at http://www.nwd-wc.usace.army.mil/tmt/documents/wmp. Since the spill levels at each project may be modified from year-to-year based on decisions made through the regional forum process, this table is updated annually. The spill levels are expressed as a minimum or maximum spill in kcfs, as a % of river flow or as a gas cap. For example, Bonneville's minimum spill level is 50 kcfs with a 75 kcfs during the daytime. Lower Granite has a maximum spill of 19 kcfs using the RSW for 24 hours. The Ice Harbor spill level is 45 kcfs during the day. Examples of spill in % of the total river flow are JDA with 60% at night and zero spill during the day until June 20th. The Dalles spill level is set as 40% of instantaneous river flow. Little Goose gas cap of 120% in the tailwater and 115% in the forebay is examples of spill levels being set by the total dissolved gas levels.

Table 1
Spill Guidance Table

Project	Planning Dates	Time	Spring Spill	Summer Spill	Amount	Minimum Generation Requirements kcfs
Lower Granite	April 3 - June 20	24 hours per day	Yes	No	19 kcfs (RSW with training)	11.5 [a]
Little Goose	April 3 - June 20	1800 - 0600	Yes	No	120/115 % TDG gas cap	11.5 [a]
Lower Monumental	April 3 - June 20	24 hours per day	Yes	No	50 % of project outflow if outflows are less than 75kcfs or greater than 100 kcfs [e]	11.5 [a]
Lower Monumental	April 3 - June 20	24 hours per day	Yes	No	45 % of project outflow if outflow is between 75 and 100 kcfs [e]	11.5 [a]
Ice Harbor	April 3 - August 31	500 - 1800 [d]	Yes	Yes	45 kcfs	7.5 - 9.5 [a]
Ice Harbor	April 3 - August 31	1800 - 500 [d]	Yes	Yes	120/115 % TDG gas cap	7.5 - 9.5 [a]
McNary	April 10 - June 20 [b]	1800 - 500	Yes	No	120/115 % TDG gas cap	50
John Day	April 10 - May 15	1800 - 600	Yes	Yes	60 % of project outflow up to 300 kcfs. Then 180 kcfs	50
John Day	May 15 - June 20	1900 - 600	Yes	Yes	60 % of project outflow up to 300 kcfs. Then 180 kcfs	50
John Day	May 15 - June 20	1900 - 600	Yes	Yes	Minimum spill is 30% of project outflow	50
John Day	June 21 - August 31	24 hours per day	Yes	Yes	30% of project outflow	50
The Dalles	April 10 - August 31	24 hours per day	Yes	Yes	40% of project outflow	50
Bonneville	April 10 - August 31	nighttime [c]	Yes	Yes	120/115 % TDG gas cap	30
Bonneville	April 10 - August 31	daytime [c]	Yes	Yes	75 kcfs	30
Bonneville	April 10 - August 31	24 hours per day	Yes	Yes	Minimum spill is 50 kcfs	30

2. **Final Updated Proposed Action – Projected Avg. Seasonal Flows**: The November 24, 2004 Final Updated Proposed action (UPA) includes a discussion on how the projected seasonal average flows at Lower Granite determines when transport of juveniles will be initiated and spill for fish passage will end. The timetable for when transport will begin is based on projected average seasonal flows and is summarized in the Table 2.

Table 2
Projected Avg Seasonal Flows
At Lower Granite, Little Goose and Lower Monumental

	<70 kcfs	70 – 85 kcfs	>85 kcfs
Transport	Maximize	Initiate Collection April 20th	Initiate Collection April 20th
Bypass	None	Bypass Through April 19th	Bypass Through April 19th
Spill	None	Spill Through April 20th	Spill (see Table 4)

With projected average seasonal flows of less than 70 kcfs per day, there will be no spill and maximum transport. With projected average seasonal flows between 70 and 85 kcfs per day, spill will occur through April 20 and transport collection will be initiated on April 20. With projected average seasonal flows greater than 85 kcfs per day, spill will occur at transport projects as described in Table 2 shown above and transport collection will be initiated on April 20.

3. **Fish Tests Cause Changes to the ESA Requirements:** The spill levels established in the 2005 Water Management Plan are modified as part of proposed fish tests that are discussed in the Spring Summer Update of the Water Management Plan. The tests that are planned for each spill season is discussed in the Fish Passage Plan, Appendix A and in the Spring Summer Update of the Water Management Plan. When spill or fish passage tests occur, flow and/or spill alterations may occur which would cause TDG levels to fluctuate. The tests for the 2005 spill season are:

   - **Lower Granite**: Fish passage test to evaluate the behavioral guidance structure (BGS) effects on fish passage. Normal BiOp spill with 12 hours to gas cap during spring and above BiOp spill during summer. Test may be affected by low water year.
   - **Little Goose:** First year fish survival test. Operations include 12 hours of nighttime spill to gas cap. Test may be affected by low water year.
   - **Lower Monumental**: Test to determine location and need for RSW. Operations include spilling 24 hours per day at 45 or 50% of outflow or to the gas cap. Schedule is mid April through Mid June.
   - **Ice Harbor:** Fish test evaluating the RSW. Operations include two treatments that are yet to be determined. Test will continue even during low flow years. Schedule is mid April through Mid June and July 1 through July 30
   - **McNary:** Fish survival test with two treatments spill to better define spill operations for 12 vs. 24 hour. Schedule is mid April through Mid June.
   - **The Dalles:** This is the 2nd year of testing the new spill wall for fish passage and survival. Normal BiOp operations of 40% spill 24 hours per day. Schedule is April 20 through July or when water temperatures are above 71 ^{o}F. This test may be cancelled because of the spillway gate repairs.
   - **Bonneville:** This is the 2nd year of testing the new B2 Corner Collector. Operations are normal BiOp spill of 75 kcfs daytime spill and gas cap spill at night. Schedule is from April 20 – end of July or when the water temperature goes above 71 ^{o}F

4. **Gas Caps:** The Oregon and Washington variances establish TDG limits of 115% for forebay's and 120% for tailwater's. These TDG limits are embodied in the gas caps issued in teletypes 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: Both the Oregon and Washington variances set 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/html/ .

b. 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.

c. Exceedences Tracking: The Corps keeps track of the date, number, reason and actions taken for the exceedences that occur. The exceedence tracking summary is discussed at the TMT meeting and available on the TMT web page at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

d. List of Daily Gas Caps: The Corps maintains a list of the gas caps determined for each project. A summary of these gas caps can be found at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

5. **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 check_spill program tracks of the amount of voluntary spill that represents UPA spill for fish. The check_spill program generates graphs of the UPA spill, actual spill, TDG levels and flow that are used during the daily spill evaluations and changes.

b. 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. There are a total of 25 tributary gauges with flow and/or temperature and the report showing hourly data is shown at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/wqreport.txt . 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.

6. **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. The Fish Passage Plan, Bon-13, Table Bon –6 which is shown below, provides the currently definition for Bonneville.

Table BON-6. Daytime spill schedule for Bonneville Project.

Date	Daytime Spill	
	Begin	End
Jan 01 – Jan 19	700	1730
Jan 20 – Feb 14	630	1800
Feb 15 – Mar 01	600	1830
Mar 02 – Apr 02	530	1900
Apr 03 – Apr 20	500	2030
Apr 21 – May 16	500	2100
May 17 – May 31	430	2130
[1]Jun 01 – Jul 31	430	2200
Aug 01 – Aug 15	500	2145
Aug 16 – Aug 31	500	2030
Sep 01 – Sep 16	530	2000
Sep 17 – Oct 04	600	1930
Oct 05 – Oct 19	630	1900
Oct 20 – Oct 29	630	1830
Oct 30 – Nov 30	600	1700
Dec 01 – Dec 31	630	1700

[1] Start date for sockeye passage varies.

7. Firm Generation Commitments

The various projects are entitled to a certain amount of flow for power generation at all times if they choose to use it. The information in Table 3 is taken from Table 4 of the Updated Proposed Action (UPA) and is a list of the flows associated with firm generation commitments.

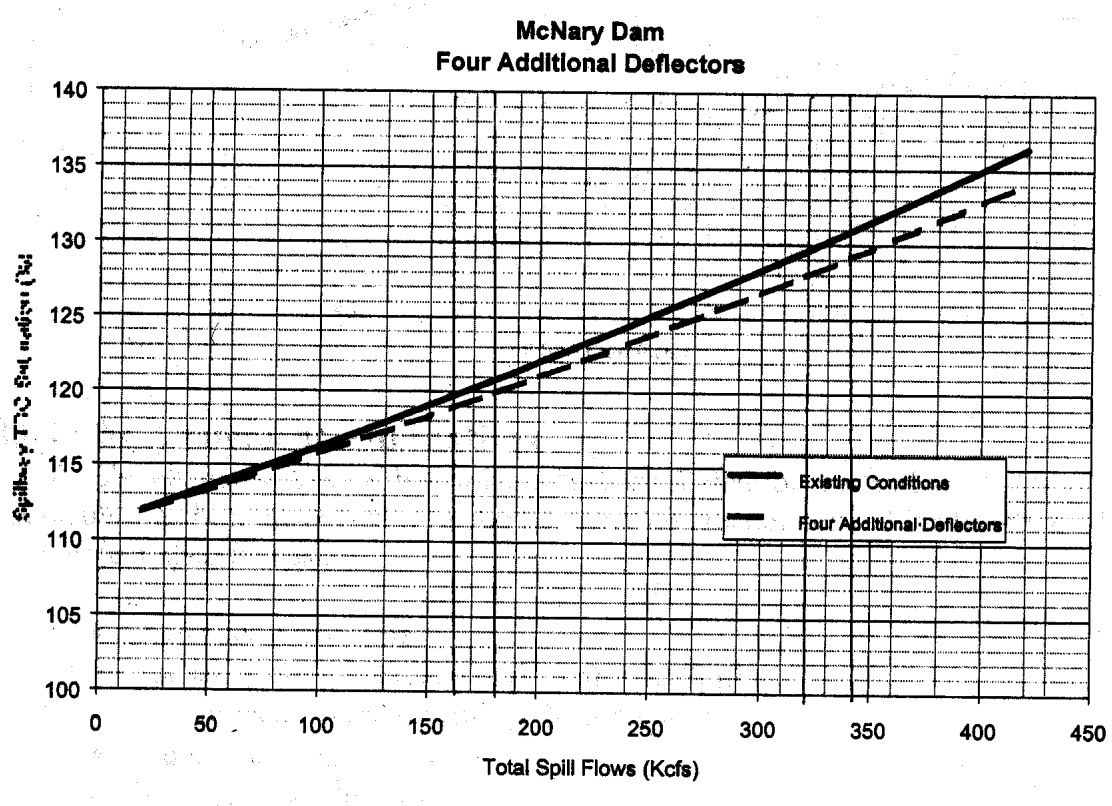
Table 3

Firm Generation Commitments Flows	
Project	**Flows in kcfs**
Lower Granite	11.5
Little Goose	11.5
Lower Monumental	11.5
Ice Harbor	7.5 - 9.5
McNary	50
John Day	50
The Dalles	50
Bonnesville	30

8. **Basic Adjustment 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.

9. **DGAS Report Project-by-Project Guidance**, There are 60% DGAS Report. Project TDG Performance Graphs that provide the relationship between spill flows and TDG levels at a constant temperature. The following graph is an example of graphs that exist for the eight Corps projects on the Columbia and Snake Rivers. (Use existing conditions)



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 decision. Table 4 provides estimated travel times for water to travel from one project to the next on the Columbia and Snake Rivers.

Table 4

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 5 and 6 show the information used to get the travel time for the Dworshak to Lower Granite reach.

Table 5

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 6

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 gas cap and spill levels must be 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 gas cap and spill levels must be increased on Monday.

13. **Holiday Guidance**: Total River Flow can significantly decrease on holidays, causing a resulting increase in TDG. As a result, the gas cap and spill levels must be 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 post information daily on the forecasted temperatures, which are available at http://137.161.65.209/weather/10_day.cgi.

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

- 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 120 KCFS generate much higher TDG levels than at 80 or 140 KCFS. This anomaly causes difficulty in regulating spill levels.
- Bottlenecks in the Rivers: – The flow deflectors at certain projects allow higher spill levels than in the past. But as a result, certain projects become bottlenecks in segments of the river. For example, if Warrendale were operated at 120% then Camas/Washougal would be in exceedance of the 115% TDG gas cap most of the time when the total river flow is above 200 Kcfs. Similar phenomena occur at Lower Granite, Little Goose and Lower Monumental river segments in the Snake. If Little Goose is operated at 120% then Lower Monumental forebay would be in exceedance of the 115% TDG gas cap most of the time.

17. **Physical Limitations:** There are three physical limitations that effects how the fish move and spill is distributed 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
- **Mechanical Failure at McNary**: During the 2003 spill season some of the gates at McNary could not be lifted due to under designed lifting beams. As a result, the gates

will have limited usage during the 2004 spill season as further work was performed to remedy the situation. The extent that these repairs resolved the issues will be seen during the 2005 spill season.

- **Mechanical Failure at The Dalles**: The cables that are involved in lifting the spillway gates at the Dalles were found to be deteriorating to such an extent that spillway bay gates 3 – 6 will need to be established at a fixed setting and moved as little as possible. It is planned that spillway bays 1 and 2 will be used to change spill daily to ensure that 40% of total river flow is spilled, TDG levels are within state standards and minimize eddies formed from bulk spill.

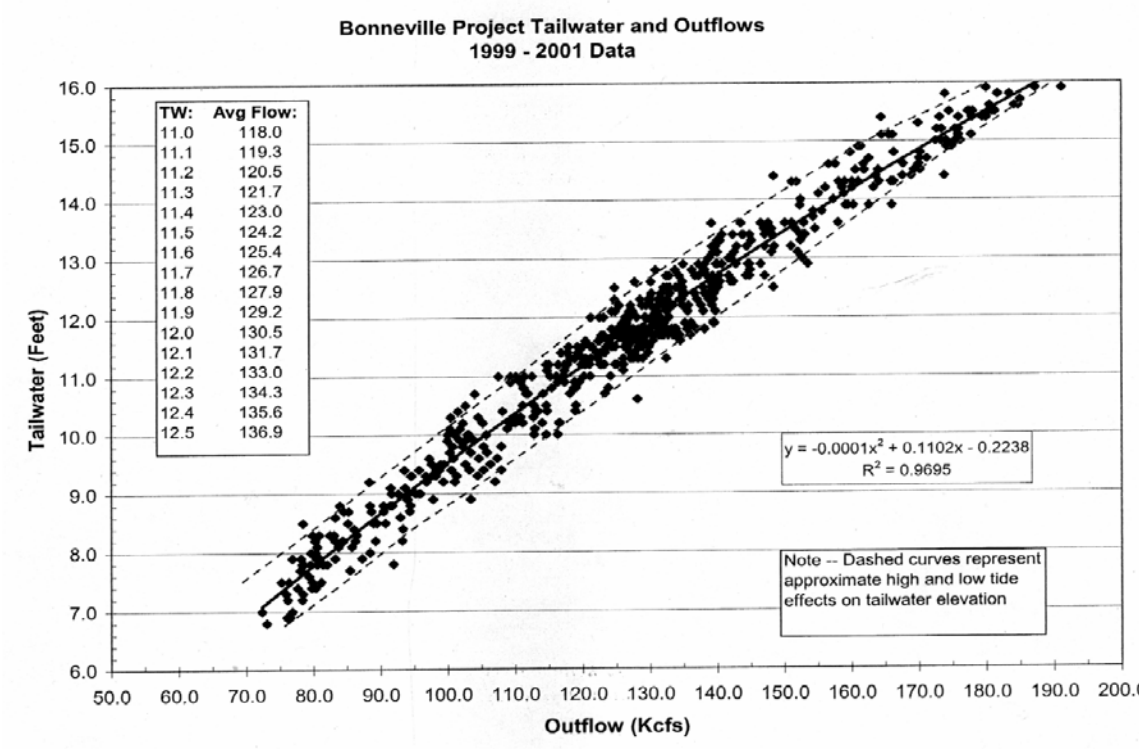
  Spill Amount for Pendant settings
  4ft settings = spill levels between 24.8 kcfs and 46.5 kcfs
  6ft settings = spill levels between 36.8kcfs and 72.0 kcfs
  8ft settings = spill levels between 54.0 kcfs and 84.0 kcfs

18. **Flow Forecast**: The Corps reservoir regulators run computer programs that generate flow forecast for the Columbia and Snake Rivers. These are stored on Corps internal files and are not available for the public.

19. **SYSTDG Model**: The Corps will continue to beta test the SYSTDG model during the 2005 spill season as an integral part of the spill program. The Corps will continue to use SYSTDG to run forecast simulations to predict what the TDG levels will be with different conditions and hind cast to see what the TDG levels would have been if conditions for a day in the past were entered.

    A statistical evaluation of the predictive errors on how well SYSTD performed was completed on the 2004 spill season data and will be on the 2005 spill season data too. The results of the evaluation will be included in the 2005 Annual TDG and Temperature Report.

20. 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 % of TDG that redds can endure is influenced by the Bonneville tailwater elevation. The following graph illustrates the relationship between project outflow to tailwater elevation. and it is to determine spill in conjunction with the graph that shows relationship.



21. Generation Capacity Limitations: There are limitations on how much water the powerhouse generators can physically handle. These powerhouse generator capacities are shown on the following table 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 7

Powerhouse Capacities	
Project	**Powerhouse Capacity (kcfs)**
Bonneville	288
The Dalles	375
John Day	322
McNary	232
Ice Harbor	106
Lower Monumental	130
Little Goose	130
Lower Granite	130