2004 Total Dissolved Gas Management Plan

1.0 Introduction

High total dissolved gas (TDG) saturation levels are observed in various parts of the Columbia and Snake River systems where spills occur, sometimes creating conditions that may adversely affect fish survival. Therefore, a plan to control TDG is developed annually along with a water management plan based on the runoff and the resulting spill for that year. This document outlines the TDG management plan adopted by the Technical Management Team (TMT) for 2004. It includes a review of voluntary and involuntary spill, applicable management options, expected flow and spill conditions, and a detailed TDG management plan with spill priority list and spill caps. This plan reflects relevant provisions of both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (NMFS) Federal Columbia River Power System (FCRPS) Biological Opinions (BiOps).

2.0 Voluntary and Involuntary Spill

2.1 Voluntary Spill

Voluntary spill occurs primarily to assist juvenile salmon passage. This operation is done to decrease residence time of juvenile salmon in the forebay of the dam and to provide a passage route that in many instances has a higher survival rate than most other routes of passage at the dam. The amount of voluntary spill is adjusted so that the resulting TDG levels associated with spill are consistent with applicable State water quality criteria.

Another reason for spill is for flow augmentation. Both the NMFS and USF&WS BiOps call for flow augmentation in the Columbia and Snake Rivers. There are instances where spill at some projects is required to obtain the flow objectives called for in these BiOps.

A coincidental side benefit of this flow augmentation is the ability to attenuate high water temperatures in the Lower Snake River. Since the forebay waters above Dworshak dam are highly stratified in the mid to late summer, and flows through the dam can be taken from varying depths (through the use of vertically adjustable powerhouse intake gates, regulated outlets (RO's) tubes, and the spillway gates), a range of tailwater temperatures can be selected. This allows for the ability to pass colder waters past the dam thereby reducing water temperatures in the Lower Snake River for the benefit of fish species.

2.2 Involuntary Spill

Involuntary spill, is caused primarily by project and/or system operational limitations. There are two primary causes for involuntary spill:

1. When an above average water supply results in flows which exceed the hydraulic capacity of power generation facilities, and

2. When potential power generation from above average water supplies exceeds the available market, especially during light market hours at night and on weekends.

Other causes for involuntary spill includes management of reservoirs for flood control, scheduled or unscheduled turbine unit outages of various durations, passing debris, or any other operational and/or maintenance activities required to manage project facilities. For example, in managing the project for flood control, the water supply forecast may underestimate the seasonal streamflows and cause the project operators to leave too little space in the reservoirs to catch the water. In other instances, unusually high winter precipitation may force the operators to store water in the reservoirs above the flood control elevations, causing involuntary spill to occur later as the water is evacuated to get to the reservoir flood control elevations.

Isolated instances of involuntary spill, prompted by scheduled or unscheduled turbine unit outages of various durations and/or other operational and maintenance activities, are expected to occur in 2004.

The (February 04) January through July runoff volume forecasts indicate that 2004 will be [to be determined] and [to be determined]. As a result, it is anticipated that spill, both voluntary and involuntary, will prevail throughout the system.

3.0 Management Options

3.1 NMFS 2000 BiOp Spill Guidance:

The planning dates for voluntary spill for spring/summer chinook migration as called for in the 2000 NMFS BiOp are April 3 through June 20 in the Snake River and April 10 through June 30 in the Columbia River. For fall chinook migration, the planning dates for spill are June 21 through August 31 in the Snake River and July 1 through August 31 in the Columbia River (Page 9-56). The 2000 NMFS BiOp (Pages 9.6.1.7.1, Water Quality Strategy, page 9-119) calls for spilling up to the 120% TDG spill caps at the lower Columbia and lower Snake Rivers Corps projects. A discussion of spring and summer flow management objectives for the benefit of migrating juvenile salmon at Lower Granite Dam and McNary Dam is provided in Section 9.6.1.2.1 (pp. 9-55 to 9-58) of the 2000 NMFS BiOp. The specific flow objectives pursued will depend upon the April 2004 final volume forecasts. A summary of the general guidance on spill requirements and other considerations is shown below (in Table 1 and project-by-project spill requirements below). These requirements are summarized in the 2000 NMFS BiOp on pages 9-88 through 9-92.

Table 1. Summary of 2000 NMFS BiOp Spill Requirements and Other Considerations

Project[1]	**Estimated Spill Level** [2]	**Hours**	**Limiting Factor**
Lower Granite	60 kcfs	6 p.m. - 6 a.m.	gas cap
Little Goose	42 kcfs	6 p.m. - 6 a.m.	gas cap

Project[1]	Estimated Spill Level [2]	Hours	Limiting Factor
Lower Monumental	27 kcfs	24 hours	gas cap
Ice Harbor	105 kcfs (night) 45 kcfs (day)	24 hours	nighttime - gas cap daytime - adult passage
McNary	170 kcfs	6 p.m. - 6 a.m.	gas cap
John Day	140 kcfs/60% (night) [3]	6 p.m. - 6 a.m. [4]	gas cap/percentage
The Dalles	40% of instant flow	24 hours	tailrace flow pattern and survival concerns (ongoing studies)
Bonneville	105 kcfs (night) 75 kcfs (day)	24 hours	

Notes:

[1] Summer spill is curtailed beginning on or about June 20 at the four transport projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams) due to concerns about low inriver survival rates.

[2] Estimated spill levels shown in the table will increase for some projects as spillway deflector optimization measures are implemented.

[3] The TDG cap at John Day Dam is estimated at 85 to 160 kcfs, and the spill cap for tailrace hydraulics is 60%. At project flows up to 300 kcfs, spill discharges will be 60 % of instantaneous project flow. Above 300 kcfs project flow, spill discharges will be at the gas cap (up to the hydraulic limit of the powerhouse).

[4] Spill at John Day Dam will be 7:00 p.m. to 6:00 a.m. (night) and 6:00 a.m. to 7:00 p.m. (day) between May 15 and July 31.

Lower Granite Dam: Voluntary spill will begin at Lower Granite Dam on April 3rd and will end on or about June 20th. This spill will occur during the hours of 6 p.m. and 6 a.m. and will be limited by the 120% tailwater gas cap. The firm generation commitment for this project is 11.5 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

Little Goose Dam: Voluntary spill will begin at Little Goose Dam on April 3rd and will end on or about June 20th. This spill will occur during the hours of 6 p.m. and 6 a.m. and will be limited by the 120% tailwater gas cap. The firm generation commitment for this project is 11.5 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

Lower Monumental Dam: Voluntary spill will begin at Lower Monumental Dam on April 3rd and will end on or about June 20th. This spill will occur 24 hours each day and will be limited by the 120% tailwater gas cap. The firm generation commitment for this project is 11.5 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

Ice Harbor Dam: Voluntary spill will begin at Ice Harbor Dam on April 3rd and will end on August 31st. This spill will occur 24 hours each day and will be limited by the 120% tailwater gas cap. Daytime spill (hours 5:00 a.m. to 6:00 p.m.) will be for adult passage purposes and will be set at 45 kcfs. Nighttime spill (hours 6:00 p.m. to 5:00 a.m.) will be to the TDG gas cap. The firm generation commitment for this project is 11.5 kcfs. However, this minimum depends on the stat us of generation at other projects and may not be necessary at all times.

McNary Dam: Voluntary spill will begin at McNary Dam on April 3rd and will end on August 31st. This spill will occur during the hours of 6 p.m. and 6 a.m. and will be limited by the 120% tailwater gas cap. The firm generation commitment for this project is 50 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

John Day Dam: Voluntary spill will begin at John Day Dam on April 3rd and will end on August 31st. This spill will occur during the hours of 6 p.m. to 6 a.m. and will consist of 60% of instantaneous flow or to the 120% TDG tailwater gas cap whichever is lower. There will be no daytime voluntary spill. The firm generation commitment for this project is 50 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

The Dalles Dam: Voluntary spill will begin at The Dalles Dam on April 3rd and will end on August 31st. This spill will consist of 40% of instantaneous flow or to the 120% TDG tailwater gas cap whichever is lower. Spill will occur 24 hours per day. The firm generation commitment for this project is 50 kcfs.The firm generation commitment for this project is 50 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

Bonneville Dam: Voluntary spill will begin at Bonneville Dam on April 3rd and will end on August 31st. This spill will occur 24 hours each day. Daytime spill (hours 6:00 a.m. to 8:00 p.m.) will be for the purpose of minimizing adult fallback and will be set at 75 kcfs. Nighttime spill (hours 8:00 p.m. to 6:00 a.m.) will be to the TDG gas cap. The firm generation commitment for this project is 30 kcfs. However, this minimum depends on the status of generation at other projects and may not be necessary at all times.

3.2 Spill Management to the TDG Gas Caps:

Spill caps will be assigned to each project and will be adjusted in-season, based on actual TDG readings. In this case, there is no spill priority list to follow except for minor adjustments to take best advantage of the 120% TDG limits (115% TDG limit measured at Camas-Washougal is applied to the spill for-fish-passage at Bonneville). For example, to account for cumulative impacts, some spill reduction may be needed at upstream projects so that some meaningful spill can still occur in the lower river within the stated 120% TDG limits. The decision on where to cut or increase spill is highly fish-dependent, and will be based on salmon managers' recommendations.

Management options are limited to the following:

- More water can be stored in the reservoirs behind the dams,
- The quantity of spill can be shifted to various periods within the day,
- More water can be put through the turbines,
- Spill can be shifted within the system to avoid excessive local concentrations,
- Spill can be transferred outside the system, and
- Spill bays can be used more effectively.

Changing the spill from a crown to a uniform pattern, avoiding the use of spillway bays without deflectors, and allowing turbine units to operate outside their 1% peak efficiency flow range are additional management options. Proper scheduling of service and maintenance time tables, identifying additional energy loads to serve, and displacing available thermal projects that are serving the same loads also help relieve the need for spill. Some of these mitigation measures have potential impacts on the environment, fish survival, and other reservoir regulation requirements. Further, they must be implemented early enough in the season to be fully effective.

To maintain uniformly low TDG conditions or to avoid spill in river reaches where the greatest number of fish are actively migrating, spill may be distributed to various other projects in a pre-planned sequence. This requires starting with projects with the least propensity for developing high TDG level or those located outside the fish migration corridor. A spill priority list will establish the order in which projects will start spilling and the maximum amount of water these projects are allowed to spill.

4.0 Projected High Spill/High TDG Periods

Pertinent water supply forecasts issued by the River Forecast Center for key locations on the Columbia and Snake Rivers are summarized in Table 2. The 2004 (April Final) January through July forecast for the Columbia River at The Dalles is [to be determined] million acre-feet (maf), [to be determined] of normal. The April through July runoff forecasts for Reclamation reservoirs above Brownlee are [to be determined] percent of normal range.

Table 2. 2004 Runoff Volume Forecasts [to be determined]

Location	Jun Final '00	% of Normal April Fin. '03

Libby (Apr-Sep) *		
Hungry Horse (Apr-Sep)		
Grand Coulee (Apr-Sep)		
Dworshak (Apr-Jul) *		
Lower Granite (Apr-Jul)		
The Dalles (Apr-Sep)		
Brownlee(Apr-Jul)		

(*) COE official Forecast

Consequently, there are no projected high spill/high TDG periods for the spring or summer of 2004. [to be determined]

The COE Power Branch made a 59-year (1929-1987) monthly flow computer simulation based on the March Final 2004 runoff forecasts at Lower Granite and The Dalles. The model simulation provides an estimate of the expected flows at Lower Granite and McNary for any of the 59 years having the January through July runoff volume as the water supply volume forecasted for 2002. The results of the 59-year monthly study are superceded by weekly spreadsheet flow projections made more specifically for 2004.

The Power Branch's analysis produced a wide range of flow and spill conditions as a result of meeting relevant 2004 system requirements for flood control, power, Libby sturgeon operation, and the BiOp seasonal flow objectives. Using the monthly simulation output from this power model run, a more detailed analysis was performed to provide expected ranges of TDG levels. Three years with different timing for peak runoff were selected and used in a more detailed simulation of the spill operation on an hourly basis. The first two water years (1934 and 1957) had their peak runoff in April and in May respectively. Runoff in the third water year (1951) was more normally distributed. Shown in Table 3 are the projected spill and TDG levels for the 3 years at Lower Granite, Ice Harbor and McNary.

Table 3. Projected Flow, Spill, and Max. TDG at Lower Granite, Ice Harbor, and McNary

Projects/ Characteristics	**1934 (Early Runoff)**	**1951 (Normal Runoff)**	**1957 (Late Runoff)**
ICE HARBOR			
Peak Runoff Period	April 11-30	April 11- May 26	May 1-26
High Flow, kcfs	145-180	106-133	123-146
High Spill, kcfs	90-100	90-95	82-95
Max Hourly TDG, %	122	122	122
MCNARY			
Peak Runoff Period	April 14-30	April 25-30	May 2-31
High Flow, kcfs	423-462	367-440	388-459
High Spill, kcfs	250-292	200-270	240-270
Max Hourly TDG, %	137	132	135
JOHN DAY			
Peak Runoff Period	April 14-30	April 17-June 3	May 18-May 26
High Flow, kcfs	489-530	321-406	422-468
High Spill, kcfs	188-230	143-150	136-167
Max Hourly TDG, %	133	127	129

The regression equations used to predict TDG are based only on the spill level. The spill caps shown are also equation-predicted spill values that yield 120% TDG.

Table 4 summarizes periods with TDG in excess of the 120% saturation levels, assuming a 2004 runoff distribution similar to that of the 3 years analyzed.

Table 4. Projected Spill Periods with TDG > 120% TDG

Projects/ Characteristics	**High TDG Periods in 1934 (Early Runoff)**	**High TDG Periods in 1951 (Normal Runoff)**	**High TDG Periods in 1957 (Late High Runoff)**
ICE HARBOR			
Pwh Cap=94			
Night Cap = 95 kcfs			
Day Cap = 45 kcfs			
Days > 120%	0	0	0
Max Daily TDG, %	120	117	117

MCNARY Pwh. Cap.=175 kcfs Spill Cap = 150 kcfs Days > 120% Max Daily TDG, %	April 2 - May 27 36 133	April 25 - May 3 9 125	May 1-June 2 33 131
JOHN DAY Pwh. Cap.=301 kcfs Spill Cap = 150 kcfs Days > 120% Max Daily TDG, %	April 18-May19 16 132	April 28-May 1 3 122	May 1 - June 5 31 128

Based on these projections, TDG below McNary would exceed the 120% saturation level for extended periods (one to two months). Daily TDG below Ice Harbor stayed at a level of 120% or less.

The results shown above are for planning purposes and are not indicative of the limited extent and much smaller magnitude of the spill conditions that may be expected for 2004. More reliable flow projections will be made starting in late March, using the results of the SSARR run adjusted as needed to meet the seasonal flow objectives at Lower Granite, Priest Rapids, and McNary. The projected seasonal average flows derived from the weekly flow projection spreadsheet will be shown in the following format:

Lower Granite: 4/03 - 6/20: X1 kcfs; 6/21 - 7/31: X2 kcfs

Priest Rapids: 4/10 - 6/30: Y1 kcfs

McNary: 4/20 - 6/30: Z1 kcfs 7/01 - 7/31: Z2 kcfs

5.0 2004 TDG Management Plan

The 2004 TDG Management Plan is similar to previous years' plans. Storage reservoirs will be operated to flood control rule curves and are projected to provide some cushion that will minimize incidences of involuntary spill. No pre-emptive reservoir drafting below flood control elevation will be attempted, as the Salmon Managers are also concerned about reservoir refill. Flows will be regulated to maximize potential for voluntary spill. When project voluntary spill occurs, the projects will be operated to try to keep TDG at or below 120% as long as possible without jeopardizing flood control objectives. When TDG cannot be managed to 120%, the river will be managed in the best interest of listed and proposed salmon stocks. It is recognized that measures designed to physically reduce TDG could have significant impact on migrating salmon. Therefore, input from state and tribal salmon managers and TDG will be sought when attempting to use those TDG control measures.

The essence of the 2003 TDG Management Plan (see Figures 1 and 2), which may be modified in-season by the TMT if necessary, is as follows:

- Implement spill for fish passage at all mainstem Federal dams as specified in the 2000 NMFS BiOp up to the spill caps for 120% TDG given in the Attachment at the end of this Appendix. Adjust spill as needed, based on real-time TDG data, and fish movement and biological conditions in that order.

- Operate unit operation within 1% of peak efficiency.

- Limit daytime spill at Bonneville to avoid adult fallback.

- Accommodate special spill requirements/restrictions for research, adult passage, etc. that have the full endorsement of all concerned parties. Also, continue to implement fish transportation program as agreed to and using calculation method endorsed by NMFS (or an equivalent method agreed to at TMT).

- If systemwide TDG exceed 120%, update and implement the spill priority outlined in Attachment 1, with incremental system TDG control objectives. Unless and until a different reach priority is recommended by the TMT, spill will start from the lower river and work its way upstream.

- Discontinue or postpone field research and non-critical unit service and maintenance schedules that create (or have potential for creating) high localized TDG levels, especially when and where high numbers of listed fish are present.

- Operate turbines outside their respective 1% peak efficiency flow range at projects where measurable reduction in TDG (at least 3%, given the accuracy range of the instrumentation) and no intolerable adverse fish impacts can be expected.

- Store water at lower Snake reservoirs above MOP, if this would result in a measurable (3% or more, based on instrumentation accuracy) reduction in TDG levels.

- Experiment with promising new spill patterns.

- Implement other operations or measures recommended by the TMT or the IT. This may include appropriate changes in transportation targets when TDG exceeds levels that are universally recognized as lethal (130% more for 1 week or longer, per NMFS) or when obvious in-river lethal conditions exist.

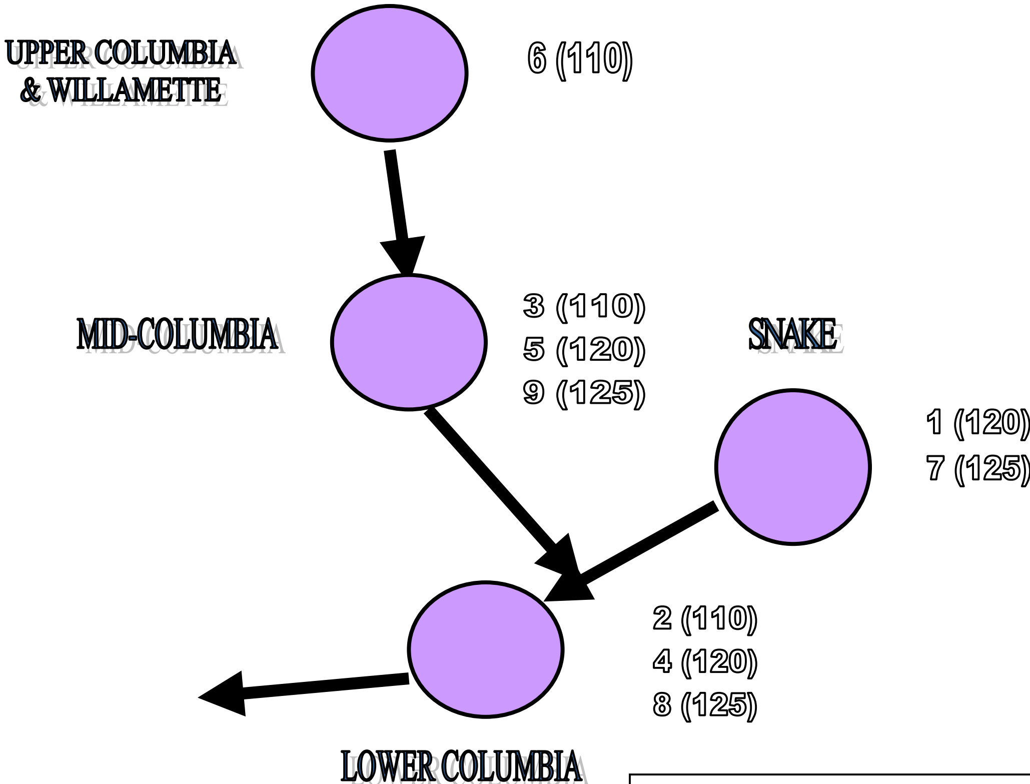

FIGURE 1: SPILL PRIORITY FOR APRIL 3 - APRIL 20

Priority (% TDG)

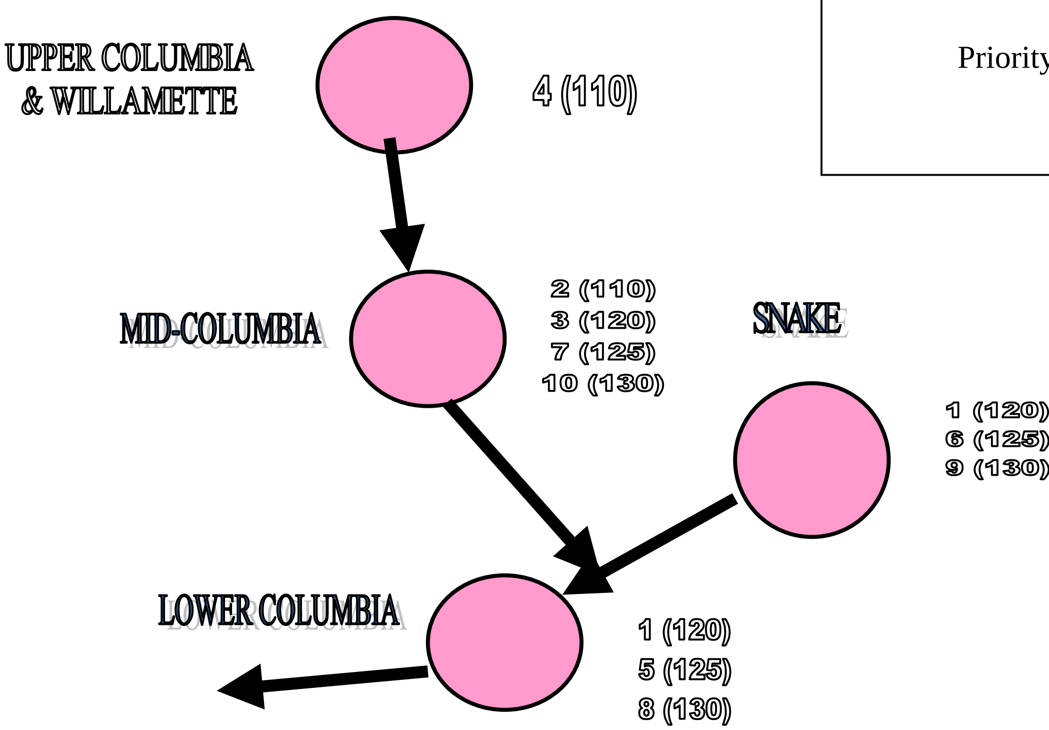

FIGURE 2. SPILL PRIORITY FOR APRIL 14-AUGUST 31

Priority (% TDG)

6.0 Water Quality Actions Related to the 2000 NMFS and USF&WS Biological Opinions

One- and five-year water quality plans are to improve fish passage and survival through water quality improvement measures. The intent of the water quality plans is to recommend FCRPS facility and operational improvements related to water quality, total dissolved gas and water temperature monitoring, and related studies. All water quality RPAs listed in Appendix B, Table B-2 of the BiOp are not organized in separate Water Quality 1-year or 5-year plan, as defined in RPA 5 (NMFS BIOP Section 9.4.2.4 Page 9-29, Action 5).

All of the water quality RPAs listed in Table B-2 are divided into two categories. Operationally oriented water quality RPAs are addressed in the 1-year and the 5-year Water Management Plans. The other capital investment water quality RPAs related to facility improvements are addressed in the 1-year and the 5-year RM&E Plans.

6.1 TDG Monitoring

Too high a level of Total Dissolved Gas can be lethal to fish. Environmental monitoring at the dams is necessary to ensure that gas levels do not exceed TDG thresholds established in the BiOp and variance levels established by the state water quality agencies. According to the BiOp, the monitoring program is to include QA/QC components, including redundant and backup monitors at as many locations as the Water Quality Team determines necessary; calibration of monitoring equipment at least every 2 weeks; adequate funds for spot-checking monitoring equipment, error checking, correcting, and recording function for CROHMS data; and daily reporting. The QA/QC components are to be reviewed by the Action Agencies annually in coordination with the Water Quality Team.

RPA 131 will be addressed in the manner described in the paragraph above, except for the redundant monitoring. The Action Agencies will establish data Quality Objectives, in coordination with the Water Quality Team, to replace the redundancy identified in the BiOp. As part of the QA/QC component of the program, achievements of the Data Quality Objectives are to be evaluated by the Action Agencies annually, in coordination with the Water Quality Team (NMFS BIOP Section 9.6.1.7.2 Page 9-122, Action 131).

In 2002 we established data quality objectives (DQO) at existing stations instead of establishing redundant stations.

Physical and biological monitoring described in RPA 131 includes QA/QC components to TDG data collection and includes redundant monitoring. The Corps presented suggested modifications to RPA 131 to the Water Quality Team at the March 12, 2002, meeting. The suggested modifications included a vigorous QA/QC program that would eliminate the need for redundant monitoring. The data quality criteria procedures are characterized in three parts: calibration protocols (data quality control), data review and corrections (data quality assurance), and completeness of data (a substitute quality assurance program for station redundancy). The Water Quality Team agreed with the suggested modifications.

The laboratory calibration protocols include use of National Institute of Standards and Technology (NIST) national standards to calibrate secondary standards in the laboratory; availability of two TDG probes dedicated to each site; lab calibration of the secondary instrument before the bi-monthly rotation; and calibration of barometric pressure, total gas pressure, and water temperature within +/-1 mm/Hg for gas and 0.2°C for water temperature of the primary standards. Primary and secondary standards criteria were developed for water temperature, barometric pressure, and total gas pressure. The primary standard for water temperature is a mercury thermometer and the secondary standard is a laboratory hydrolab unit. The primary standard for barometric pressure is a National Weather Service barometer, and the secondary standard is a hand-held barometer. The primary standard for total gas pressure is a digital pressure gauge calibrated to NIST standards. The secondary standard is a laboratory hydrolab unit that is checked to four pressures, and calibrated to a two-point curve. Field calibration protocols include bi-monthly TDG probe laboratory calibration of the secondary hydrolab unit, rotation to the field, and field calibration. Also, the barometric pressure, total gas pressure, and temperature sensors are field calibrated within 0.2 mm/Hg and 0.2°C of the secondary standard.

Data review and correction procedures include daily visual review of the numeric data, looking for signs of erroneous data or mechanical problems. Questions have been developed for a data checklist that is completed daily. For example: Are more than 25% of the hourly values for total dissolved gas missing or exhibiting intersite comparisons of greater than 20 mm Hg? or Are spill changes needed to explain any Pt values? Reviews of graphs of the data are also used to visually detect 1-hour anomalies. After the data is reviewed, two steps can be taken with data that has questionable quality. If there is a constant amount of shift or continual drift, the data can be corrected. If there is no justifiable means for correcting the data, the data is deleted from the database.

The data quality criteria for the completeness of the data include that 95% of the data that could have been collected during the defined monitoring period for each station is complete. The completeness evaluation is based on temperature and percent TDG, which encompasses barometric pressure and TDG pressure. Data completeness is based on an entire suite, not on the completeness of one parameter.

The data collected during the 2002 spill program will be evaluated in the fall of 2002, and will be presented to the Water Quality Team in early 2003, so that guidance for the 2003 program can be incorporated.

6.2 TDG Monitoring Review

Total Dissolved Gas (TDG) measurements in the forebays and tailwaters of the dams have been monitored as part of the NMFS spill program. In-season management to improve juvenile fish survival relies on the TDG monitoring program. Based on review of possible biases in the TDG data, NMFS believes that some forebay locations, such as the Camas site, have to be changed to provide a more representative measure of TDG in the water passing through the dams. It is possible that spill could be increased if current forebay locations over-represent the level of gas saturation in the water of the forebays.

RPA 132 addresses the development of a plan to systematically review and evaluate TDG fixed monitoring site forebays at all the mainstem Columbia and Snake dams, especially the Camas site.

The Water Quality Team created an RPA 132 subcommittee to address systematic review of the forebay TDG Fixed Monitoring Stations. The subcommittee reviewed the forebay station issues related to spill for fish passage in the fall of 2001, identified the highest priority locations, and recommended a detailed systematic review of many of the Columbia /Snake forebays at Corps projects.

Especially mentioned in RPA 132 was the Camas/Washougal site in the lower Columbia River. To address the representativeness issues of the Camas/Washougal site (downstream of Bonneville Dam), which is used as a forebay index station for the estuary, the Portland District Corps performed data collection during the 2002 spill season at Corbett, Oregon. TDG data collection was from March through mid-September 2002. Sampling was at 15-minute intervals. A presentation concerning overview observations of TDG was made to the WQT on September 10, 2002. A report on the study, with conclusions and recommendations will be available in early 2003.

A remote water quality data sonde was installed at the west end of The Dalles powerhouse in April 2002. It was an auxiliary forebay monitor installed to evaluate the traditional fixed monitoring site (TDA) located at the east end of the powerhouse. The purpose of the study was to evaluate lateral variability of the TDG levels at the project. The instrument was removed in mid-September 2002. A presentation concerning overview observations was made to the WQT on September 10, 2002. A report on the study, with conclusions and recommendations, will be available in early 2003.

Studies were also initiated in 2002 to evaluate vertical thermal gradients in the forebays of the lower Columbia dams. A vertical string of water temperature loggers were placed in the forebays of Bonneville, The Dalles, and John Day dams from April to September 2002. Instruments in the Bonneville forebay were deployed at 1, 5, 10, 20, 50, and 80 feet at one station approximately 1,000 feet upstream of the dam. Two strings of water temperature loggers were installed approximately 1,000 feet upstream of The Dalles forebay. One string was at the shallow north side of the forebay at 1, 5, 10, 20, 40 and 60 feet. The deeper south side depth intervals were at 1, 5, 10, 20, 60 and 100 feet deep. The John Day forebay also had two strings of loggers about 1,000 feet upstream of the dam. The John Day instrument depths were at 1, 5, 10, 20 60, and 100 feet for both stations that have similar maximum depths. A report, with conclusions and recommendations, will be available in 2003.

The Corps Walla Walla District is preparing a 2003 contract to review and analyze exiting TDG and water temperature data for representativeness and anomalies. Site visits will be conducted to identify and investigate potential alternative forebay locations for Fixed Monitoring Stations. Automated data loggers will be installed at selected forebay locations at each project. Analyses for TDG and water temperature performance and representativeness will be prepared in report form, including conclusions and recommendations. The schedule includes:

Task	Description	Completion
1	Conduct review and analysis	31 December 2002
2	Site Visits	28 February 2003
3	Install instruments	31 March 2003
4	Collect and analyze data	30 June 2003
5	Draft Report	1 August 2003
6	Final Report	15 September 2003

In 2002, Seattle District initiated a study of temperature in Rufus Woods Lake, the reservoir of Chief Joseph Dam. The purpose of the study is two-fold; 1) to assess potential bias in TDG measurements from thermal stratification in the forebay, and 2) to identify temperature increases along the 50-mile reservoir. Vertical strings of temperature sensors were installed at the upstream and downside ends of the reservoir. After two summers of data collection, the study report will be completed in FY2004.

6.3 TDG Model

Total Dissolved Gas caused by large volumes of water spilled over dams can result in injury and mortality of juvenile salmonids. Development and continued refinement of a systemwide TDG model would assist with in-season management of involuntary spill.

The Corps developed TDG models to be used as a river operations management tool. According to NOAA Fisheries RPA 133, the Corps was to develop the tool(s) by spring 2001. The Corps is to coordinate the systemwide management applications of the gas abatement model(s) with the annual planning process, the Transboundary Gas Group, the Mid-Columbia Public Utilities, and other interested parties (NMFS BIOP Section 9.6.1.7.2 Page 9-124, Action 133).

The Corps developed the SYSTDG model to assist with operational decisions related to TDG. Training in use of the model was provided by BPA to regional entities on February 27/28, 2001, and March 6/7, 2001. Model results for varying flow levels were used in 2002 to provide day-to-day guidance at the most difficult water quality monitoring site in the Columbia/Snake system to meet water quality standards, Camas/Washougal. Model development in 2002 included updating TDG production relationships, technical review, statistical summary of data, and update documentation.

6.3.1 Temperature model and Temperature Monitoring Needs

Water temperature caused by impoundment of pools behind dams can result in a change in the water temperature regime of the river, potentially causing injury and mortality of juvenile salmonids. NOAA Fisheries Biological Opinion RPA 143 identifies the need for development, and continued refinement of a Snake River water temperature model would assist with in-season management of voluntary spill. The model is to be used as a pre-season planning tool to provide predicted operations in real time to assist in the in-season water management decisions.

The Water Quality Team created an RPA 143 subcommittee in the spring of 2002. Participants include representatives from NOAA Fisheries, CRITFC, EPA, Idaho Power Company, IDEQ, NMFS, ODEQ, Fish Passage Center, Battelle, BPA, USACE and WDOE. The workgroup first met March 8, 2002, and met monthly in the remainder of 2002. Meeting minutes are available from the subcommittee chair, Rick Emmert, of the Walla Walla District COE.

Objectives of the subcommittee are:

- To gain an understanding of causes and effects and controlling processes in relation to stream flows, temperatures, and fish response;
- To understand how best to use Dworshak reservoir water to affect flow and temperature conditions in the Snake River for the fish; and
- To document and describe this understanding for management of temperature conditions.

The team posed and ranked relevant questions that needed to be answered to adequately address the measure. The questions were organized in a matrix. The next step included developing a list of existing data (1970s to present), models and reports done by others to avoid repeating work that was already in progress or had already been completed. While developing a list of existing data, the team noted that data collection efforts in the river during the 2002 summer could benefit from a supplemental data collection effort to support the RPA measure 143 work and moved ahead with additional data collection in the river for the summer/fall months of 2002. This work is in progress and will be completed this next year (March 2003).

Once data efforts are completed, responses will be written for as many identified questions as possible**.** Questions that have not been addressed and new questions that have been identified will then determine the model selection. Following model selection, a data collection strategy to support modeling efforts will be prepared. A second year of field data collection may be implemented based on model selection and the data collection strategy. Finally, draft and final reports will be prepared, with recommendations.

The workgroup determined that there is an extra effort by agencies and organizations to collect temperature and other data in the Lower Snake River during the 2002 summer. A table of temperature and other data sets that relate to temperature conditions has been compiled; this table shows the site name, location, agency or organization collecting the data, type of data, months the data were collected, frequency of data collection, specifics on how or where the data were collected and who to contact to get the data.

The Idaho Power Company addressed the workgroup on July 22 regarding their water-quality monitoring and modeling results of the Snake River from Farewell Bend to Asotin, Washington.

Mike Schneider of the COE presented to the workgroup a summary of existing and potential temperature models that are or could be used on the Lower Snake River at the April 12 meeting of the workgroup.

Findings associated with the Idaho/Oregon TMDL, EPA TMDL, fish ladder temperatures, flow and temperature operations at Snake River dams operated by the COE, and how spilling potentially could affect temperatures have not been completed as of September 2002.

The following schedule is proposed for completion of the plan. This schedule assumes we can get all data collected in 2002 organized by March 2003.

Task	Target Completion Date
Complete review of existing data and reports	May 2003
Complete data collection/analysis and reporting	July 2003
Selection of model(s)	August 2003
Development of data collection strategy	September 2003
Implement data collection strategy (optional)	June – Nov 2003
Prepare draft report or plan	November 2003
Review (subgroup team and WQT)	December 2003
Prepare final report	January 2004
Model development (optional)	To Be Determined

6.3.2 Water Quality Database

As part of Cumulative Risk Initiative evaluations, NMFS has focused on the need for a single comprehensive data management system to enable integration of monitoring and evaluation information with information from other sources. The application of performance standards and measures will require additional data collection and analysis. Validation of the approach, and of specific actions taken, will require continual confirmation that the measures are sufficient to avoid jeopardy and facilitate recovery of listed salmonids (NMFS BiOp Section 9.6.5.4 Page 9-127, Action 198).

The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, have been designated to develop a common data management system for fish populations, water quality, and habitat data as identified in RPA 198 of the NOAA Fisheries 2000 Biological Opinion.

The Columbia River Operational Hydromet and Management System (CROHMS) database is currently being used to provide the real time TDG and temperature data for the daily operations of the Columbia and Snake Rivers. Using this database, the Corps calculates the highest 12-hour TDG averages. The Corps is in the process of switching from CROHMS, a DSS database system developed in the 1960's to the Corps Water Management System (CWMS) database, a Oracle database system with current technology. As part of the conversion process, the NWD has developed a computer program that calculates the highest 12-hour TDG averages using CWMS as the data source. The results of these calculations can be found at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/. Since CWMS currently contains only 10 months of data, the computer program had to use CROHMS data to generate the highest 12-hour TDG average for all dates prior to November 2002. The highest 12-hour TDG averages generated with CWMS data is being compared against the highest 12-hour TDG averages generated with CROHMS data. The comparison and assessment continues and will be completed before the beginning of 2004-spill season.

Attachment
SPILL PRIORITY LIST and SPILL CAPS (April 20 - August 31)

1. This attachment provides project priority for spill and allowable spill levels to be used in an attempt to control total dissolved gas (TDG) to 120%, 125%, 130% and 135%. Projects are listed in a sequential order, placing first priority on spilling at mainstem Columbia projects before spilling at projects outside the fish migration corridor (HGH, Willamette, etc). See also Figure 1.

2. When systemwide TDG is at or below 120%, provide the spill for fish passage up to the 120% TDG spill caps in the following order:

   - Spill up to the 120% TDG spill caps at McNary (MCN), John Day (JDA, The Dalles (TDA), Bonneville (BON), Lower Monumental (LMN), Little Goose (LGS), and Lower Granite (LWG);

   - Spill up to the 110% TDG spill caps at projects outside the lower river fish migration corridor: Priest Rapids (PRD), Rocky Reach (RRH), Wells (WEL), Rock Island (RIS), Wanapum (WAN), Chief Joseph (CHJ), Grand Coulee (GCL), and Dworshak (DWR) in that order. The priority order for the mid-Columbia projects is as recommended for the period beyond April 15 by the Mid-Columbia Coordinating Committee;

   - Spill up to the 120% TDG spill caps at projects where State standards waivers have been granted: PRD, RRH, WEL, RIS, and WAN in that order;

   - Spill up to the 120% TDG spill caps at DWR if release from DWR is for use in maintaining 100 kcfs flow at LWG;

   - Spill up to the 110% TDG spill caps at Hungry Horse (HGH) and Willamette Projects.

3. When systemwide TDG exceeds 120% TDG, then try to control systemwide TDG to 125%, then to 130% and so on by spilling up to the spill caps indicated for those TDG levels, at lower Columbia, Snake, mid-Columbia, HGH, and Willamette Projects in that order. To accommodate the 64/30 tests, the spill priority for The Dalles will be such that spill at this project can follow the 64/30 alternating percent requirement as much as possible. The spill level at John Day may also be dictated by the test at The Dalles.

4. Spill caps for various applicable TDG levels are provided below. They will be updated as needed, based on real-time TDG information.

Table A-1. Spill caps (in kcfs) corresponding to 110 to 135 % TDG Levels

PROJECT	TDG%	TDG%	TDG%	TDG%	TDG%	TDG%	REMARKS
	110	115	120	125	130	135	
MCN	20	80	170	250	340	410	(NEW DATA)
JDA	40	90	160	300	400	450	(NEW DATA)
TDA	50	100	200				(NEW DATA)
BON	70	120	170	250	300	370	(NEW DATA)
IHR	20	45	85	120	145	160	(NEW DATA)
LMN	35	40	45	70	170	250	(NEW DATA)
LGS	30	35	50	80	200	250	(NEW DATA)
CHJ	05	27	30	33	50	70	(NEW DATA)
LWG	20	40	60	90	130	190	(NEW DATA)
DWR	03	07	12	15	15	15	(NEW DATE)
WAN	10	15	20	50	100	200	
PRD	25	30	40	100	210	350	
RIS	05	10	20	30	150(1)	300	(LIMITED DATA)
RRH	05	10	20	30	150(1)	300	(LIMITED DATA)
WEL	10	15	25	45	130(1)	250	(LIMITED DATA)
GCL(2)	0 20	5 25	10 30	20 75	35 120	55 170	
HGH	03	3	3	3	3	3	
HCR	04	4	6	6	6	6	
LOP/DEX	05	5	5	5	5	5	

PROJECT	TDG%	TDG%	TDG%	TDG%	TDG%	TDG%	REMARKS
GPR	02	2	2	2	2	2	
DET/BCL	07	7	7	7	7	7	
TDG %	110	115	120	125	130	130	

1. Limit daytime spill to 100 kcfs
2. Assume forebay TDG at 120% (1st row=outlet El<1260'), 2nd row=spillway (El>1260')
3. HGH spill to 3 kcfs (110% TDG) until further notice