

# **Appendix B**

**2010 - 2014 Dissolved Gas**

**Monitoring Plan of Action**

**U.S. ARMY CORPS OF ENGINEERS  
PLAN OF ACTION  
FOR DISSOLVED GAS MONITORING  
IN 2010-2014**

*Updated for 2011*



**OCTOBER 2011**



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# **U.S. ARMY CORPS OF ENGINEERS PLAN OF ACTION FOR DISSOLVED GAS MONITORING IN 2011**

## **Part 1: Introduction**

The U.S. Army Corps of Engineers (Corps) operates its Federal Columbia River Power System (FCRPS) projects for multiple project purposes consistent with applicable laws and regulations. The operation of the Corps' FCRPS projects has potential effects on water quality and Endangered Species Act (ESA) listed fish. Accordingly the Corps considers the ecological objectives of the Clean Water Act and the ESA, and complies with the applicable water quality standards to the extent practicable as well as conducting operations consistent with applicable Biological Opinions.

The 2010 NMFS FCRPS BiOp (2010 BiOp) includes spill operations at Corps mainstem projects for listed juvenile salmon and steelhead passage. Currently, the fish passage spill operations during the juvenile migration season (generally early April into August) are consistent with court-ordered operations and the adaptive management provisions in the 2010 BiOp. The intent of the spill operations is to help meet juvenile fish survival performance standards identified in these BiOp. These fish passage spills may result in the generation of total dissolved gas (TDG) supersaturation in the Columbia and lower Snake Rivers at levels above current state and federal water quality standards. The states of Washington and Oregon have authorized exceptions to these standards to assist out-migrating threatened and endangered salmon smolts during the fish passage season.

During fish passage season, April – August, the Corps reviews project operations and TDG production daily and sets spill caps to manage TDG within the water quality standards waiver and criteria adjustment. The Corps provides the region with real-time monitoring and reporting of TDG & temperature parameters from the fixed monitoring sites and uses this information for spill management and fish passage decisions.

The purpose of this Plan of Action is to outline the details of the overall Corps monitoring program and summarize the roles and responsibilities of the Corps as they relate to dissolved gas and temperature monitoring. This Plan of Action also identifies channels of communication with other cooperating agencies and interested parties. This Plan of Action summarizes what to measure, how, where, and when to take the measurements and how to analyze and interpret the resulting data. It also provides for periodic review and alteration or redirection of efforts when monitoring results and/or new information from other sources justifies a change. Some information on the complementary activities of other participating agencies is provided at the end of this document. This Plan of Action covers the TDG monitoring activities from April 1, 2011 through August 31, 2011. However, with regional coordination, this Plan of Action may be modified as necessary to keep current with system operations, regulatory requirements, and technical innovations.

## Part 2: General Approach

The TDG and temperature monitoring program consists of a range of activities designed to provide management information about dissolved gas and spill conditions. These activities include time-series measurements, data analysis, synthesis and interpretation, and calibration of numerical models. Four broad categories of objectives are involved:

- 1) Data acquisition, to provide decision-makers with synthesized and relevant information to control dissolved gas supersaturation on a real-time basis;
- 2) Real-time monitoring, to ascertain how project releases affect water quality relative to the 2010 BiOp measures and existing state and tribal dissolved gas standards;
- 3) Trend monitoring, to identify long-term changes in basin-wide dissolved gas saturation levels resulting from water management decisions; and
- 4) Model refinement, to enhance predictive capability of existing models used to evaluate management objectives;

Portland, Seattle and Walla Walla Districts have direct responsibility for TDG monitoring at their respective projects, including data collection, transmission, analysis, and reporting. The Northwestern Division Reservoir Control Center (RCC) coordinates this activity with the Districts, other State and Federal agencies, and private party stakeholders as needed to insure the information received meet all real-time operational and regulatory requirements. Districts and RCC roles and functions are described in more detail in Section 3 of this document.

The Corps considers TDG monitoring a high priority activity with considerable potential for affecting reservoir operations and ongoing regional efforts to protect aquatic biota. The Corps will make all reasonable efforts toward achieving, at a minimum, data quality and reliability levels comparable to that provided in previous years.

Of the 28 gauges that the Corps operates and maintains in the Columbia Basin, 17 of them are essential to the real-time operations of the main stem projects associated with the 2010 BiOp, the Court ordered implementation, and TDG TMDL performance. These gauges are essential to the spill for fish passage program April through August. As such these gauges maintain the most stringent data management and quality performance standards. Table 1 (p. 17) provides a breakdown of the gauge network and groups them in three categories regarding the sensitivity of their performance.

The Corps believes it is important to maintain a two-way communication between those conducting the monitoring and the users of monitoring information. This communication gives decision-makers and managers an understanding of the limitations of monitoring and provides technical staff with an understanding of what questions should be answered. Comments and recommendations received from users are very useful in establishing monitoring program priorities and defining areas requiring special attention.

## Part 3: Districts and Division Responsibilities

### 3.1 District Functions

Portland, Seattle and Walla Walla Districts will perform all the activities required at their TDG monitoring sites. Data will be collected and transmitted from those sites systematically and without interruption to the Columbia River Operational and Hydromet Management System (CROHMS) operational database. Data can be accessed from the Dataquery website at: <http://www.nwd-wc.usace.army.mil/perl/dataquery.pl>. Some of the gauges record continuously while others are seasonal (see Table 1). For seasonal gauges, TDG data may be collected outside of the prescribed time periods. The amount of data collected outside the time period will depend upon when the gauge is initiated and when the gauge is removed at the end of the season. Gauges are often installed several weeks prior to the initiation date to ensure reliable data at the start of the season. Some gauges remain installed to monitor special operations or unusual environmental conditions. Others are left in past the end of the season due to unavailability of technicians to remove the gauge. Data acquired outside of the specified season may not be reliable because maintenance of these gauges outside of the season is limited.

District responsibilities include, but are not limited the following tasks:

- assist the Division office in the preparation of the annual Plan of Action for Dissolved Gas Monitoring and schedule for gauge installation;
- procuring data collection/transmission instruments;
- preparing and awarding equipment and service contracts;
- performing initial instrument installation and testing;
- setting up and removal of permanent monitoring installations, if requested;
- evaluate existing stations to ensure that measured TDG levels are representative of true river conditions;
- collecting and transmitting TDG data to CROHMS and CWMS databases;
- reviewing data for early detection of instrument malfunction;
- conducting periodic calibration, service and maintenance calls;
- providing emergency service calls as needed and/or when so notified;
- performing special TDG measurements, if needed;
- keeping records of instrument calibration and/or adjustments;
- retrieving, servicing, and storing instruments at the end of the season;
- providing final data corrections to the Division office and into the CROHMS and CWMS databases;
- preparing an annual activity report;
- document and report QA/QC performance;

All three Districts will be responsible for (1) preparing an annual report on instrument performances, and (2) providing the necessary material including test and data analyses, charts, maps, etc. for incorporation in the Corps annual Total Dissolved Gas and Water Temperature Monitoring Report, which will be finalized by the Division. Additional monitoring at selected locations may be required on an as-needed basis subject to available funding. Data dissemination to non-Corps users will remain an RCC function. A general overview of the TDG

monitoring system is available at [http://www.nwd-wc.usace.army.mil/tmt/wqnew/monitoring/2008\\_Monitoring\\_Stations.pdf](http://www.nwd-wc.usace.army.mil/tmt/wqnew/monitoring/2008_Monitoring_Stations.pdf).

To better understand the physical process of dissolved gas distribution across the reservoirs and its dissipation along the various pools, selected transect studies will continue to be conducted on an as-needed/as-funded basis. An additional objective for this activity is to be able to continually verify that readings from current monitoring sites are representative of the entire river reach.

### **3.2 Division Functions**

RCC will be responsible for overall coordination of the TDG monitoring program with the Districts, other State and Federal agencies, and cooperating parties. The RCC Water Quality Team Lead is responsible for coordinating these efforts.

The RCC Water Quality Team Lead (Coordinator) will provide overall guidance to District counterparts to ensure that the monitoring program is carried out in accordance with the plan outlined in this document, including close adherence to a general schedule and operating quality assurance and quality control (QA/QC) protocols. The Coordinator will be the main point of contact for all technical issues related to the TDG monitoring at Corps projects, will refer problems of common regional interest to relevant regional forums for peer review and open discussion, and will facilitate final decision-making on technical issues based on all relevant input from interested parties.

The Coordinator will coordinate with District counterparts annually between November and December to update the monitoring Plan of Action and the schedule for the upcoming year. Discussion will cover monitoring sites, equipment, data collection and transmission procedures, service and maintenance, budget, communication needs, etc. A set of specific performance measures will be jointly prepared as a basis for reviewing and monitoring District performances. The revised Plan of Action will be finalized in January ensuring a mutual understanding of the current objectives of the TDG Monitoring Program, including data to be collected, instrument location, procedures to be used, special requirements, etc. are in place allowing service contracts to be finalized and issued by the Districts in a timely manner for the upcoming spill season. An annual post spill season monitoring system review meeting will be held annually to review operations and identify areas needing changes and improvements.

## **Part 4: 2011 Plan of Action**

The 2011 Plan of Action consists of the following phases observed in previous years spill for fish passage seasons and fall-winter monitoring. These phases are as follows:

1. Program start-up;
2. Instrument Installation;
3. In-season Monitoring and Problem Fixing;
4. Data Quality Process;
5. Data Quality Criteria;
6. Instrument Removal and Storage;
7. Fall-Winter Monitoring;

8. Data Compilation, Analysis and Storage;
9. Program Evaluation and Report; and
10. Special Field Studies

#### **4.1 Program Start Up**

All three Districts will request that adequate funding is available for 2011 monitoring activities, and will prepare the proper contracts to secure the necessary equipment and services to conduct the monitoring program in each of the years. All cooperative agreements, maintenance and service contracts should be completed at least two weeks before the instruments are installed in the field. Where applicable, the Districts will ensure that real estate agreements and right of entry are finalized between the landowners and the Corps. All paper work for outside contracts will be completed no later than January 31(subject to funding constraints and availability).

To date, the Districts have been initiating the necessary cooperative agreements and service contracts to continue operation and maintenance of the fixed monitoring stations (FMS) through the 2011 fall-winter monitoring season. Districts and RCC have finalized the current QA/QC protocols. Thermister strings that monitor temperature at several depths throughout the year and report data hourly have been placed in Dworshak Dam, Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, Ice Harbor Dam, and McNary Dam.

Discussions between Districts, RCC and contractors are expected to continue through December each year, at which time a final Plan of Action will be produced. It is also expected that the following entities will continue to operate their monitoring instruments in 2011:

- U.S. Bureau of Reclamation, below Hungry Horse, at the International Boundary and above and below Grand Coulee Dam;
- Mid-Columbia PUDs (Douglas, Chelan and Grant Counties), above and below all five PUD dams on the Columbia River; and

#### **4.2 Instrument Installation**

Instruments to be installed and their assigned locations are listed in Table 1 and shown in Figure 3 at the end of this document. Some of them are already in place for the 2011 fall-winter monitoring.

All seasonal instruments are scheduled to be in place and connected to their data collection platforms no later than April 1 for all stations, except the stations downstream of Bonneville Dam (Camas-Washougal, Cascades Island, and Warrendale). The latter will need to be activated earlier to monitor TDG levels during chum operations. Similarly, the Warrendale gauge, a fall-winter season gauge, will be kept active until late May to facilitate monitoring of TDG impacts on chum redds below Bonneville Dam.

Corps FMSs that remain in service during the fall-winter season continue their operation with minimum interruption into the spring, following the necessary instrument service and maintenance check-up and site equipment upgrades. These FMS include the tailwater monitor at each lower Columbia and lower Snake River project, with the exception of the Warrendale gauge discussed above.

An assessment of monitoring site integrity will be conducted. Any damages that may have occurred over the fall-winter will be fixed before proceeding with calibration and testing. Selected project personnel may be requested to assist on this task as needed.

### **4.3 In-Season Monitoring and Problem Fixing**

Data collection and transmission will begin no later than April 1<sup>st</sup> for the entire monitoring network, with the exception for gauges downstream of Bonneville Dam as noted above. The exact starting date will be coordinated with the RCC Water Quality Team Lead, project biologists and cooperating agencies, based on runoff, spill, and fish migration conditions.

The following data will be collected every hour:

- Water Temperature (°C);
- Barometric Pressure (mm Hg);
- Total Dissolved Gas Pressure (mm Hg);
- Gauge Depth (feet)

Data will be collected and transmitted at least hourly. If feasible, the previous 8-12 hours of data will also be sent to improve the capability of retrieving any data that may have been lost during the preceding transmission. For most gauges, data transmission will be done via the GOES Satellite, to the NESDIS and retransmitted to another LRGs DOMSAT satellite and finally to the Corps ground-receive station in Portland. After decoding, all data will be stored in the CROHMS and CWMS databases. Per cooperative agreements with Portland and Walla Walla Districts, the USGS captures and stores the data into ADAPS (the USGS's internal Automated Data Processing System). Data transmission at Libby and Albeni Falls (gauges operated by the Seattle District) will be done via radio to the NWS HEC-DSS database and the data sent via file transfer protocol (ftp) to the CROHMS and CWMS databases. Data transmission from Chief Joseph is transmitted via GOES satellite.

Given their direct relevance to fish mortality, the first three parameters (temperature, barometric pressure, and TDG pressure) will be collected on a first priority basis.

Daily reports summarizing TDG and related information (except for Libby and Albeni Falls Projects) are posted on the Technical Management Team's (TMT) home page <http://www.nwd-wc.usace.army.mil/tmt/> and RCC Water Quality home page (accessible from the Technical Management Team (TMT) website), under Spill Review Information (<http://www.nwd-wc.usace.army.mil/tmt/wqnew/>). Information provided on the homepage will include some or all of the following data:

- Station identifier;
- Date and time of the probe readings;
- Water temperature (°F);
- Barometric pressure (mm Hg);
- TDG pressure (mm Hg);
- Calculated TDG saturation percent (%);
- Project hourly spill discharge (kcfs);

- Project generation discharge (kcfs);
- Project total hourly outflow [total river discharge] (kcfs);
- Probe depth (feet);
- Project forebay and tailwater elevation (feet)

#### **4.4 Data Quality Process**

The 2000 Biological Opinion called for redundant TDG monitoring system. Through regional negotiations, it was agreed that the Corps would develop data quality criteria and data completeness sets that would meet regional data needs including two dedicated TDG probes available at each station to provide redundancy in lieu of a duplicate monitoring system. One exception is at JHAW where there is a dual TDG sensor probe operating at all times. From 2000 through 2002 the Corps, in cooperation with the Regional Forum Water Quality Team (WQT), developed a set of QA/QC protocols for operating TDG gauges. These protocols are included in the monitoring Plan of Action and detailed in the District Data Quality Data Assurance (QA/QC) Data Evaluation Report. The District QA/QC data evaluation reports provide a discussion of Quality Control and Quality Assurance functions including bi-weekly calibration, spot-checking of monitoring equipment and the accuracy, precision and completeness of the data needed at each FMS. The FMS will be assessed at the end of the monitoring season against these criteria and a data QA/QC evaluation report will be included in the annual Total Dissolved Gas and Water Temperature Monitoring Report. Adjustments and proactive steps will be made to the individual FMS that do not perform to the objectives described.

#### **4.5 Data Quality Criteria**

As a general overview, the Data Quality Criteria for FMS include having two dedicated TDG probes available for each site, so that lab calibration can be performed on one probe while the other probe is in the field operating. For Portland and Walla Walla District gauges, this rotation will occur once every three weeks during the spill season and monthly during the fall-winter months. For Seattle District, this rotation will occur bi-monthly during the spill season. Seattle District does not operate their TDG gauges during the fall-winter months. Once the probe is deployed, it is again calibrated and/or checked. The data from the FMS operated by the Portland and Walla Walla Districts is sent to USGS and the Division. The USGS reviews this data and performs corrections. The Seattle District reviews and corrects their data. The data quality criteria goal is 95% data completeness for a data set.

The data quality criteria for FMS cover four main elements:

1. Calibration protocols (laboratory and field calibrations);
2. Repair of malfunctioning gauges;
3. Reviewing data quality (data quality checks and dealing with suspect data);
4. Completeness of data;

The items are described as follows.

### 4.5.1 Calibration Protocols

There are two general types of calibrations performed on FMS gauges (Laboratory Calibrations and Field Calibrations).

#### Laboratory Calibration

There are four data quality criteria associated with laboratory calibration, including 1) calibration of the secondary TDG standard; 2) the secondary barometric pressure standard; 3) the field instrument TDG sensor; and 4) secondary standard thermister. Each criterion is described as follows.

##### Calibration of Secondary TDG Standard

A secondary TDG standard is used since the primary standard created at the Laboratory cannot be used in the field. The secondary standard is calibrated with the primary standard, transported to the field and is used to calibrate the field instrument. Calibrate the secondary TDG sensor at two points using the primary National Institute of Standards and Technology (NIST) standard. The TDG pressure must be  $\pm 2$  mm Hg at both pressures; otherwise the secondary standard is recalibrated. Pressures at which the sensor is calibrated must bracket the expected range of field measurements. An index of primary and secondary standards is shown below.

PARAMETER	PRIMARY STANDARD	SECONDARY STANDARD
Temperature	NIST traceable thermometer	Multi-parameter probe
Barometer Pressure	NIST traceable barometer or digital pressure gauge.	Hand held barometer
Total Gas Pressure	Digital pressure gauge calibrated to NIST	TDG Probe

##### Calibration of Secondary Barometric Pressure Standard

Calibrate the secondary standard barometer at ambient barometric pressure to the NIST standard. The barometer must be  $\pm 1$  mm Hg of the primary standard (NIST certified instrument) otherwise the secondary standard is recalibrated.

##### Calibration of Field Instrument TDG sensor

The two point TDG sensor calibrations must agree within  $\pm 2$  mm Hg at both pressures, otherwise the sensor is recalibrated. Pressures at which the sensor is calibrated must bracket the expected range of field measurements.

##### Calibration of Secondary Standard Thermister

The instrument's thermister must agree within  $\pm 0.2^\circ\text{C}$  with the primary NIST standard. This variance will be monitored and if the probe performs outside this range, it will be returned to the manufacturer for maintenance. A check or verification still constitutes a calibration and should be documented in records.

#### Field Calibration

There are two data quality criteria associated with field calibration; calibrations and performance checks. Calibrations include two fixed points and two point TDG sensor calibrations.

## Calibrations

- Two Fixed Points: In order to reduce TDG calibration variability, two fixed points should be chosen and incorporated in the TDG calibration protocol. For example, calibrate the first point to ambient barometric pressure, and the second point to 300 mm Hg over barometric pressure. The calibrated range for this example brackets {100% - 126 %} TDG saturation. This ensures the same calibration curve is established each time for every instrument.
- Two Point TDG Sensor Calibrations: Following the designated deployment period for a particular gauge, a two point TDG sensor calibration must agree within  $\pm 4$  mm Hg at both pressures. Pressures at which the sensor is calibrated must bracket the expected range of field measurements. If the pressure is not  $\pm 4$  mm Hg of the standard, the data will be considered “suspect” and handled as described in “Reviewing Data Quality”.

## Performance checks (Portland and Seattle Districts)

There are four data quality criteria associated with performance checks: TDG pressure compared to secondary standard; standby probes deployed; thermister compared to secondary standard; and field barometer compared to secondary standard. Each is described as follows.

- TDG Pressure Compared to Secondary Standard: After the deployment period, prior to removal of the field instrument, the TDG pressure will be compared to the secondary standard. The actual decision point regarding adjusting the data would be in the lab following the two point TDG sensor calibration described in field instrument post calibration. The field comparison actually involves sampling precision and should not be used as a decision point for shifting data.
- Standby Probe Deployed: During initial deployment of a new TDG probe, after sufficient time for equilibration (up to one hour), the TDG pressure must be  $\pm 10$  mm Hg of the secondary standard otherwise another (standby) probe is deployed.
- Thermister Compared to Secondary Standard: During initial deployment of the new instrument, the thermister will be  $\pm 0.4^\circ\text{C}$  of the secondary standard, corrected for calibration, or the instrument will be replaced with a standby.
- Field Barometer Compared to Secondary Standard: At each visit the field barometer reading should be the same as the secondary standard or the field barometer will be calibrated.

## Performance checks (Walla Walla District)

There are three data quality criteria associated with performance checks: TDG pressure and water temperature compared to a replacement sonde (which is considered a secondary standard) and field barometer compared to a secondary standard. Each is described as follows.

TDG Pressure Compared to Replacement Sonde: After the deployment period, the TDG pressure will be compared to that of the replacement sonde. Comparisons are made using one of

two methods: 1) the replacement sonde will be deployed nearby the in-place field sonde if possible; or 2) the field sonde will be removed from the deployment tube and both it and the replacement sonde will be tied together and deployed for comparison. After sufficient time for equilibration, the TDG pressures must be  $\pm 10$  mm Hg of each other, otherwise another replacement sonde is deployed for comparison. After the comparisons are made, the field sonde is removed and the replacement sonde is deployed.

- Thermister Compared to Replacement Sonde: Thermisters will be  $\pm 0.4^\circ\text{C}$  of each other, corrected for calibration; otherwise another replacement sonde is deployed for comparison.

The sensor must be deployed to a depth where the compensation depth is sufficient to accommodate the change in pressure relative to the atmosphere; otherwise the TDG measurements may be underestimated. If the site does not accommodate maintaining the probe at greater than the compensation depth for more than 95% of the measuring cycle, investigations will begin to re-locate the fixed monitoring station.

#### **4.5.2 Repair of Malfunctioning Gauges**

The Corps, and/or their contractors, will have an adequate inventory of spare instruments that will be maintained to ensure that at least one backup monitor will be made available for deployment as necessary. A malfunctioning instrument will generally be repaired or replaced within 24 to 48 hours from the time that the malfunction has been detected, depending on the remoteness of the instrument location and TDG conditions. A gauge malfunction that occurs during the weekend may require a longer response time depending upon when the detection of the malfunction has occurred, and availability of capable technician/equipment. High priority will be placed on fixing a faulty instrument when TDG levels are or expected to be in excess of the current state standards.

Corps staff and/or contractors will maintain TDG instruments. Instruments needing repairs that are beyond the staff's capability will be shipped to the manufacturer. In-house water quality and information management will do repairs of communication network systems. Service and repair of the Sutron DCP will be performed by the manufacturer. Service and repairs of the Zeno DCP will be performed by a contractor.

To help reduce response time in determining whether an emergency field visit is needed, the following decision-making procedure was developed by the WQT:

- No emergency trips are made for the parameter of temperature.
- For gas and barometric pressure, if more than 25% of the hourly values are missing, then an emergency trip is needed.
- If the difference in values between two consecutive stations is larger than 20 mm Hg for gas pressure, or 14 mm Hg for barometric pressure, then an emergency trip is triggered. This criterion does not apply if:
  - a. There is a transient "spike" for a parameter.
  - b. If the higher-than-expected gas pressure value is associated with spill operations.

- If gas parameters at a station do not fall within any of the Corps' Engineering Research and Development Center (ERDC) generated gas production curves, are not caused from operational or structural changes, and these data persist for over 48 hours, then an emergency visit is triggered.

When a FMS gauge malfunctions, the Corps will provide TMT members with an overview of the situation at the next TMT meeting including: the date the gauge malfunctioned; the cause of malfunction; and the actions taken to fix it. There are occasions when malfunctioning gauges prevent RCC water quality team from having adequate data to perform spill review and adjust spill caps and when this occurs, it is documented in the annual Dissolved Gas and Water Temperature Monitoring Report and submitted to the states as part of the TDG waiver package.

### 4.5.3 Reviewing Water Quality Data

Portland and Walla Walla District data from the FMS will be sent to both the USGS database (ADAP's) and the Corps CROHMS and CWMS database which stores the raw and revised data. The Seattle District FMS data is sent to the Corps CROHMS and CWMS database. Both the USGS and the Corps have different data review and correction processes. The USGS performs a review, correction and deletion process on ADAP's data, thus storing corrected data. The USGS data correction process includes corrections for drifts and shifts in the data. RCC performs a review and correction of the data in CROHMS and CWMS that is limited to just deletions and replacement of data for the 17 gauges that are in the spill reports to the court. The following is a brief description of the Corps data review and correction process:

Once data are received, the following review processes occur:

- Perform visual inspection of data. There are certain signs in the data that indicate mechanical problems either with the FMS, or associated special dam operations that need further investigation. Visually inspect both tabular and graphical data for sudden and extreme changes in any parameter or for missing data. Extreme changes that are observed suggest that the data may be erroneous due to the gauge malfunctions (FMS membrane failed) or calibration issues. For instance, a sudden rise of 5°C in one hour stands out and is suspect. Spikes, or changing trends, in both tabular and graphed TDG data can suggest special operations like debris spill or a speed no load operations during an equipment maintenance or repair occurred. So although the TDG data has a sudden spike, it could be accurate and reflect a possible special operation. Missing data that are observed may suggest that the transmission was not successful. Figures 1 and 2 are examples of graphs that are currently used to review TDG and temperature data.
- Once suspect data are identified, it is important to investigate the cause of the anomaly. Common causes of unusual appearances in data include: gauge membrane failure; debris spill; speed no load operations for equipment maintenance, cable/connector failure, DCP failure, vandalism, transmission failure, etc.;
- Based on the results of the investigation, the following actions can be taken:
  1. Retain the data because it is correct in spite of the unusually high values or sudden spike;
  2. Delete the data because it is erroneous and the Corps doesn't have accurate values;

3. Replace the erroneous or missing data with the correct data which are received from the USGS who maintains the Corps FMS and maintains a record of the FMS Logger data.

#### **4.5.4 Completeness of Data**

Completeness of data includes method of calculation and the data quality criteria goal.

##### Completeness Calculation

The calculation of data set completeness is based on temperature and %TDG, which encompasses barometric pressure and TDG pressure. Data completeness is not based on the completeness of one parameter; but of an entire suite.

##### Completeness Goal

Each data set collected at any site will have 95% of the data. Only “verified” data will be considered to be part of the 95%, and any suspect data will have been deleted.

#### **4.6 Instrument Removal and Storage**

The seasonal water quality sondes and cables will be removed for the winter shortly after the end of the monitoring season by Corps staff, the USGS or independent contractor, except for those that are needed for continued fall-winter monitoring. The remaining hardware remains in the locked NEMA station box. Those removed will be serviced by the maintenance and service contractors and stored until the beginning of the next monitoring season. A selected number of monitors and spare DCPs will be available for off-season monitoring activities upon request. Seattle and Walla Walla District owns its Sutron DCPs, and maintains and stores them as needed.

#### **4.7 Fall-Winter Monitoring**

Fall-Winter monitoring of TDG will be consistent with what was recommended in the TDG TMDL’s for the lower Columbia and the lower Snake rivers. A TDG monitor will be installed in the tailraces of each project.

#### **4.8 Data Compilation, Analysis and Storage**

The USGS and Columbia Basin Environmental are currently the Corps contractors who maintain the FMS stations. For the 17 gauges that are in the spill reports to the court, the USGS will fill data gaps when logger data is available and perform statistical analyses of the FMS data. The results of the statistical analyses that they perform become part of the annual QA/QC Reports that the three Districts submit as part of the annual Dissolved Gas and Water Temperature Monitoring Report. Data collected and transmitted from all network FMS will be ultimately stored in CROHMS and CWMS databases, where they can be accessed through Dataquery (<http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?help=yes>) or web reports found at RCC Water Quality home page, under the spill review information link found at <http://www.nwd-wc.usace.army.mil/tmt/wqnew/>.

#### **4.9 Program Evaluation and Summary Report**

The Corps TDG and temperature monitoring program is evaluated annually using two main approaches: The District QA/QC data evaluation reports, and the annual post spill season monitoring system review meeting. Each of the three Corps Districts prepares the QA/QC data

evaluation reports which discuss how the data quality criteria were satisfied and the reasons if they were not met. The reports include bi-weekly calibration, spot-checking of monitoring equipment, data statistics, plots and the accuracy, precision and completeness of the data needed at each FMS. These QA/QC data evaluation reports are included in the annual Total Dissolved Gas and Water Temperature Monitoring Report.

The annual post spill season monitoring system review meeting is held after spill season with the representatives from the Corps Division RCC and Policy, the three Corps Districts, the Bureau of Reclamation, Douglas County PUD, Chelan County PUD, Grant County PUDs, the state water quality programs, Bonneville Power Administration, US Fish and Wildlife and NOAA Fisheries in attendance. The three Corps Districts, the Bureau of Reclamation, and the Mid-Columbia PUD's present their QA/QC data evaluations to the region and issues are discussed. Adjustments to the monitoring program may be discussed and proactive steps may be identified so that the monitoring Plan of Action objectives are met and carried forward for the next year monitoring operations.

#### **4.10 Special Field Studies**

Special field studies are performed periodically to evaluate how structural or operational modifications at the projects might affect field parameters. Some examples include installing spillway flow deflectors, spillway weirs, and spillwalls at the projects which may change the local hydraulic conditions and influence TDG production. These field studies are often used to update the various models, e.g. SYSTDG and CE-QUAL-W2, and to insure the FMS gauges are still providing accurate and representative data. Field studies may also be performed to support TMDL and BiOp compliance.

### **Part 5: Cooperation with Participating Agencies**

The Bureau of Reclamation, Douglas County PUD, Chelan County PUD, and Grant County PUDs currently monitor for total dissolved gases at their mainstem projects and have maintained a cooperative effort with the Corps in collecting and reporting TDG and related water quality parameters. The following is a summary of the action plans for the cooperating agencies.

Bureau of Reclamation: TDG monitoring is expected to continue at International Boundary and the Grand Coulee forebay and tailrace, and the Hungry Horse tailwater. Hourly data transmission to CROHMS and CWMS will continue via the GOES satellite.

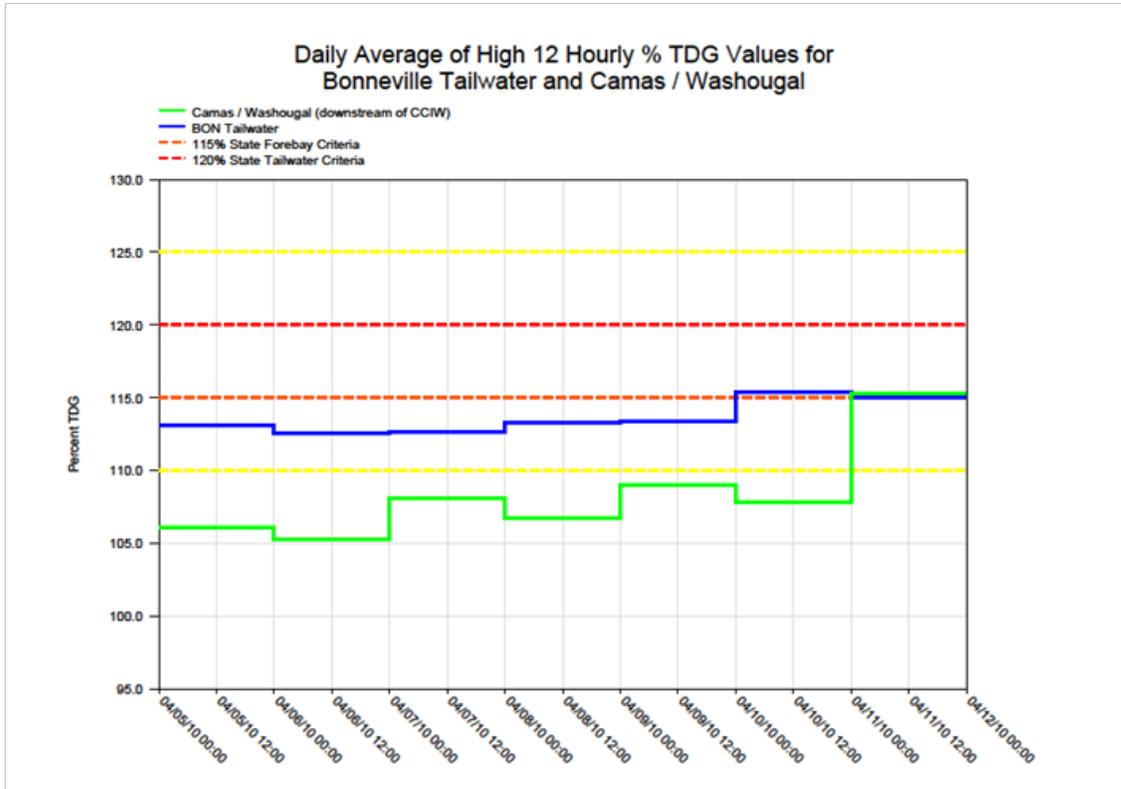
Douglas County PUD: TDG monitoring is expected to continue at the forebay and tailrace of Wells Dam. Hourly data from both of these stations will continue to be posted in the Corps CROHMS and CWMS databases.

Chelan County PUD: TDG monitoring in the forebays and tailraces of Rocky Reach and Rock Island dams is expected to continue. Hourly data from these four stations will continue to be posted in the Corps CROHMS and CWMS databases.

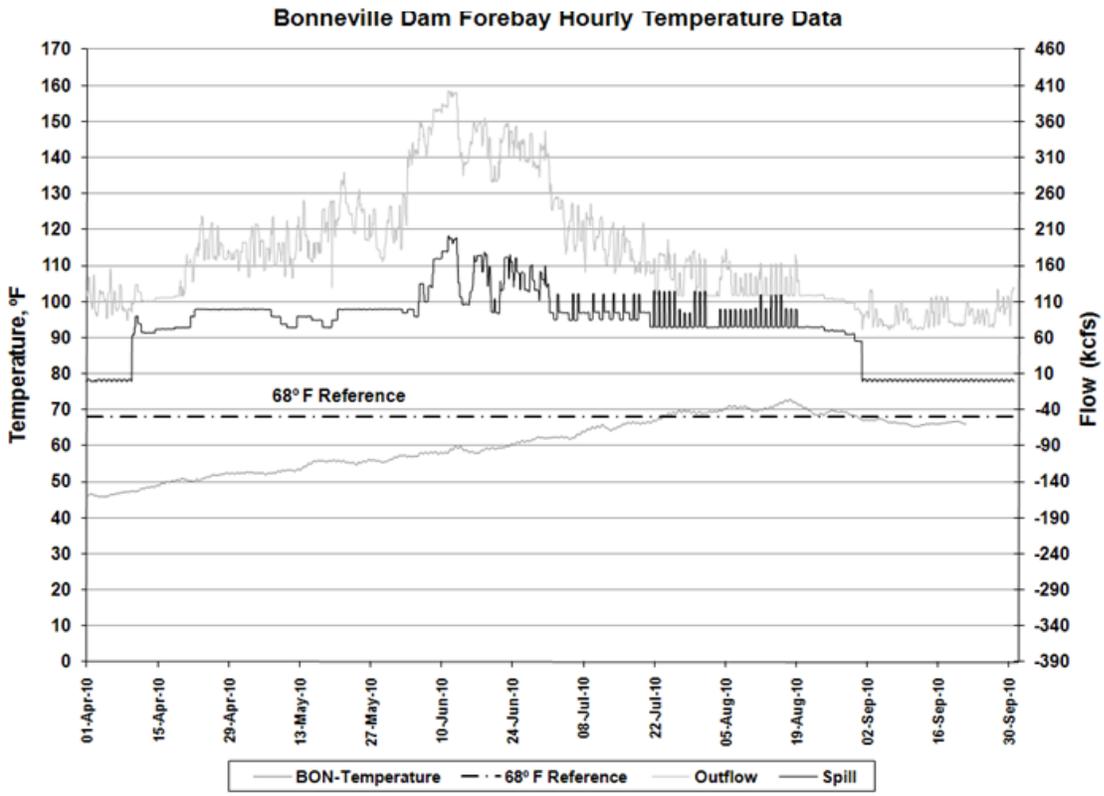
Public Utility District No. 2 of Grant County (Grant PUD): Grant PUD currently operates and maintains four fixed-site water quality monitoring stations: the forebay and tailwater gauges at

Priest Rapids and Wanapum dams. Hourly data from these four stations will continue to be posted in the Corps CROHMS and CWMS databases.

**FIGURE 1**



**FIGURE 2**





**Table 1**  
**2011 Dissolved Gas Monitoring Network**

STATION NAME	STATION CODE	OWNER <sup>d,e,f</sup>	DATES OF OPERATION	CALIBRATION		QA/QC TIER
				FALL-WINTER <sup>a</sup>	SPRING-SUMMER <sup>b</sup>	
Albeni Falls Forebay	ALFI	USACE-NWS	April 1 – September 30	N/A	2 Weeks	2
Albeni Falls Tailwater	ALQI	USACE-NWS	April 1 – September 30	N/A	2 Weeks	2
Anatone	ANQW	USACE-NWW	April 1 – August 31	N/A	3 Weeks	3
Bonneville Forebay	BON	USACE-NWP	April 1 – August 31	N/A	3 Weeks	1
Boundary	CIBW	USBR	Year Round	Monthly	2 Weeks	3
Camas-Washougal	CWMW	USACE-NWP	April 1 – August 31	N/A	3 Weeks	1
Cascades Island	CCIW	USACE-NWP	March 1 – August 31	N/A	3 Weeks	1
Chief Joseph Forebay	CHJ	USACE-NWS	April 1 – September 30	N/A	2 Weeks	2
Chief Joseph Tailwater	CHQW	USACE-NWS	April 1 – September 30	N/A	2 Weeks	2
Dworshak Tailwater	DWQI	USACE-NWW	Year Round	Monthly	3 Weeks	2
Grand Coulee Forebay	FDRW	USBR	Year Round	Monthly	2 Weeks	3
Grand Coulee Tailwater	GCGW	USBR	Year Round	Monthly	2 Weeks	3
Hungry Horse Tailwater	HGHM	USBR	April 1 – September 30	N/A	2 Weeks	3
Ice Harbor Forebay	IHRA	USACE-NWW	April 1 – August 31	N/A	3 Weeks	1
Ice Harbor Tailwater	IDSW	USACE-NWW	Year Round	Monthly	3 Weeks	1
John Day Forebay	JDY	USACE-NWP	April 1 – August 31	N/A	3 Weeks	1
John Day Tailwater	JHAW	USACE-NWP	Year Round	Monthly	3 Weeks	1
Lewiston	LEWI	USACE-NWW	April 1 – August 31	N/A	3 Weeks	3

**Table 1**  
**2011 Dissolved Gas Monitoring Network**

STATION NAME	STATION CODE	OWNER <sup>a,b,c</sup>	DATES OF OPERATION	CALIBRATION		QA/QC TIER
				FALL-WINTER <sup>d</sup>	SPRING-SUMMER <sup>e</sup>	
Libby Tailwater	LBQM	USACE-NWS	April 1 – September 30	N/A	2 Weeks	2
Little Goose Forebay	LGSA	USACE-NWW	April 1 – August 31	N/A	3 Weeks	1
Little Goose Tailwater	LGSW	USACE-NWW	Year Round	Monthly	3 Weeks	1
Lower Granite Forebay	LWG	USACE-NWW	April 1 – August 31	N/A	3 Weeks	1
Lower Granite Tailwater	LGNW	USACE-NWW	Year Round	Monthly	3 Weeks	1
Lower Monumental Forebay	LMNA	USACE-NWW	April 1 – August 31	N/A	3 Weeks	1
Lower Monumental Tailwater	LMNW	USACE-NWW	Year Round	Monthly	3 Weeks	1
McNary Forebay	MCNA	USACE-NWW	April 1 – August 31	N/A	3 Weeks	1
McNary Tailwater	MCPW	USACE-NWW	Year Round	Monthly	3 Weeks	1
Pasco	PAQW	USACE-NWW	April 1 – August 31	N/A	3 Weeks	3
Peck	PAQW	USACE-NWW	April 1 – August 31	N/A	3 Weeks	3
Priest Rapids Forebay	PRD	Grant County PUD	Year Round	2 Weeks	2 Weeks	3
Priest Rapids Tailwater	PRXW	Grant County PUD	Year Round	2 Weeks	2 Weeks	3
Rock Island Forebay	RIS	Chelan County PUD	April 1 – August 31	N/A	Monthly	3
Rock Island Tailwater	RIGW	Chelan County PUD	April 1 – August 31	N/A	Monthly	3
Rocky Reach Forebay	RRH	Chelan County PUD	April 1 – August 31	N/A	Monthly	3
Rocky Reach Tailwater	RRDW	Chelan County PUD	April 1 – August 31	N/A	Monthly	3

**Table 1**  
**2011 Dissolved Gas Monitoring Network**

STATION NAME	STATION CODE	OWNER <sup>a,b,c</sup>	DATES OF OPERATION	CALIBRATION		QA/QC TIER
				FALL-WINTER <sup>d</sup>	SPRING-SUMMER <sup>e</sup>	
The Dalles Forebay	TDA	USACE-NWP	April 1 – August 31	N/A	3 Weeks	1
The Dalles Tailwater	TDDO	USACE-NWP	Year Round	Monthly	3 Weeks	1
Wanapum Forebay	WAN	Grant County PUD	Year Round	2 Weeks	2 Weeks	3
Wanapum Tailwater	WANW	Grant County PUD	Year Round	2 Weeks	2 Weeks	3
Warrendale	WRNO	USACE-NWP	September 1 – May 31	Monthly	3 Weeks <sup>f</sup>	2
Wells Forebay	WEL	Douglas County PUD	April 1 – August 31	N/A	Monthly	3
Wells Tailwater	WELW	Douglas County PUD	April 1 – August 31	N/A	Monthly	3

a. CORPS = U.S. Army Corps of Engineers (NWP = Portland District, NWS = Seattle District, NWW = Walla Walla District)

b. USBR = U.S. Bureau of Reclamation

c. Data for all TDG monitoring stations is available at; <http://www.nwd-wc.usace.army.mil/tmt/>

d. For the purposes of Corps of Engineers TDG monitoring, “Fall-Winter Season” is defined as September 1 through March 31.

For the purposes of Bureau of Reclamation TDG monitoring, “Fall-Winter Season” is defined as October 1 through March 31.

e. For the purposes of Corps of Engineers TDG monitoring, “Spring-Summer Season” is defined as April 1 through August 31.

For the purposes of Bureau of Reclamation TDG monitoring, “Spring-Summer Season” is defined as April 1 through September 30.

f. The Warrendale TDG monitor will be recalibrated every three weeks from March 1 through May 31

**Table 2**  
**2011 List of Contact Personnel**

<b>Project</b>	<b>Name</b>	<b>Position</b>	<b>Phone #</b>	<b>E-Mail</b>
Internat'l Bondary, Hungry Horse, Grand Coulee	Norbert Cannon	Chemist	(208) 334-1540	ncannon@pn.usbr.gov
	Clyde Lay	Water Quality Regional Coordinator	(208) 685-6926	clay@pn.usbr.gov
	Jim Doty	Hydromet Data Transmission	(208) 378-5272	jdoty@pn.usbr.gov
Chief Joseph, Albeni Falls, Libby	Kent Easthouse	Oversight	(206) 764-6926	kent.b.easthouse@usace.army.mil
	Ross Emry	Trouble-shooting	(206) 764-3543	ross.d.emry@usace.army.mil
Wells (Douglas)	Beau Patterson	Coordinator	(509) 884-7191	beaup@dcpud.org
Rocky Reach and Rock Island (Chelan County PUD)	Waikele (Kelee) Hampton	Coordinator	(509) 663-8121 x 4627	waikele@chelanpud.org
	Mike Blalock	Data Manager	(509) 669-1732	
Priest Rapids and Wanapum (Grant County PUD)	Carson Keeler	Limnologist	(509) 754-5088	Ckeeler@gcpud.org
			Ext. 2468?	
	Tom Dresser	Manager of Fish, Wildlife, and Water	(509) 754-5088	tdresse@gcpud.org
			Ext. 2312	
Dworshak, Low. Granite, Little Goose, Low. Monumental, Ice Harbor, McNary, Pasco, Anatone	Steve Juul	Coordinator	(509) 527-7281	steve.t.juul@usace.army.mil
	Russ Heaton	Oversight	(509) 527-7282	russ.d.heaton@usace.army.mil
	Kevin Wright	USGS Oversight	(509) 527-2571	kswright@usgs.gov
John Day, The Dalles, Bonneville, Warrendale, Skamania, Camas	Jim Britton	Coordinator	(503) 808-4888	james.l.britton@usace.army.mil
	Joe Rinella	USGS/Contract Coordinator	(503) 251-3278	jrinnella@usgs.gov
	Dwight Tanner	USGS/Oversight	(503) 251-3289	dqtanner@usgs.gov
USACE Northwest Division Program Coordination	Scott English	Coordinator	(503) 808-3938	scott.e.english@usace.army.mil
	Laura Hamilton	Oversight	(503) 808-3939	laura.j.hamilton@usace.army.mil
	Tina Lundell	Data Manager	(503) 808-4878	tina.m.lundell@usace.army.mil